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SECTION 01000
DESCRIPTION/SPECS/WORK STATEMENT

1.0 **OBJECTIVE**: This contract is intended to provide rapid response for major repair and minor construction situations relating, but not limited to, civil, architectural, mechanical, plumbing, structural, electrical, HVAC, instrumentation, security and safety areas in a cost effective manner. Primary area of consideration is in hospital repair, renovation, maintenance and remediation as well as all related work. Civil work may include, but not limited to, grading, waterlines, sewerlines, paving/repaving roadways, sidewalks, parking lots, shore protection, stream bank stabilization, and dredging. Architectural work may include, but not limited to, painting, renovation of interior of existing buildings, new building construction. Mechanical involvement may include, but not limited to, heating, ventilation, and air conditioning (HVAC) systems and components, refrigeration systems, material transport systems, automatic box conveyor systems, incinerators, fuel lines, elevators, escalators, dumb waiters, as well as plumbing systems including water, solid and hazardous waste control. Electrical work may include, but not limited to, power and service supplies, distribution, and utilization systems (including lighting), power generators and uninterrupted power supplies (UPS). Instrumentation work may include but not limited to, plant management systems, using direct digital technology and fire alarm systems. Security work may involve intrusion detection and surveillance systems. Safety issues may include but not limited to upgrade of life safety codes, safety and hygiene, and fire suppression systems. Asbestos and lead-based paint abatement may be required during equipment systems repairs. Structural effort may also be required. Ancillary work necessary to support the repair project, such as demolition, or to restore the work area to the condition prior to the repair action will be required. This objective shall be achieved through the implementation of task orders issued under the terms of this contract for all of the herein described tasks or additional tasks described in specific task orders.

2.0 **DESCRIPTION**.

2.1 This contract shall apply to all projects within the jurisdictional execution authority of the Corps of Engineers, U.S. Army Engineer District, Honolulu, Area of Responsibility.

2.2 The term of this contract will not exceed a maximum period of thirty-six months or three years.

2.3 Upon receipt of a task order, the Contractor shall provide, all labor, materials, supplies, parts (to include system components), supervision, equipment, and related services, (except when specified as Government furnished), to perform all work in strict accordance with the terms, conditions, special contract requirements, specifications, drawings, attachments, and exhibits contained in the contract or incorporated by reference. This contract covers a broad range of primarily hospital maintenance, major repair and minor construction work. The Contractor may be asked to meet compressed schedules as required by the installation. Work will require extensive knowledge of the functional operation relating to the efficient use of the facility equipment and facility support systems, and building structures. Facilities will be in full operation during the work. In these instances, the Contractor will be required to minimize interference with the daily operations at the facilities.

2.4 The Contractor shall be familiar with and work shall conform to (but not limited) the following codes: National Fire Protection Association, Americans with Disabilities Act (ADA), and Uniform Federal Accessibility Standards (UFAS). The Contractor shall be cognizant of any changes in codes which impact these facilities. The Contractor shall notify the Contracting Officer when major modifications to the task order are required to maintain code compliance.

2.5 The Contractor's work and responsibility shall include all Contractor planning, programming, administration, and management necessary to provide all remediation (i.e. maintenance, repair, and/or construction) and related services as specified. The work shall be conducted by the Contractor in strict accordance with the contract and all applicable Federal, State, and local laws, regulations, codes, or directives. The Contractor shall provide related services such as preparing and submitting required reports, performing administrative work, and submitting necessary information as specified under this contract and within each task order. The Contractor shall ensure that all work performed meets or exceeds the scope of work and any special specifications or documents included with the individual task order.

2.6 The Government will provide a scope of work to the Contractor detailing the task to be accomplished. The detail provided may vary from a general statement of work of what is required (with no drawings) to complete design documents (drawings and specifications), depending on the complexity of the project. The Contractor will be required to use the information provided by the Government and submit a complete proposal regardless of how much information is provided by the Government. The proposal shall include the remediation method, labor and materials necessary for performing the work required.

2.7 The Contractor shall complete all work and services under this contract in accordance with schedules established in each task order. Submittal dates will be included in the task order. These dates identify when submittals are due in the issuing office and other addresses identified in the task order. Types and numbers of submittals and dates and places for review meetings shall be established by each task order.

3.0 **DEFINITIONS**.

3.1 The following terms apply to this contract (the list is not all inclusive).

3.1.1 **Site Survey**: An inspection of a facility to evaluate areas which need remediation.

3.1.2 **Feasibility Study**: A study undertaken to determine the cost effectiveness of a proposed facility remedial action.

3.1.3 **Work Plan**: A detailed package consisting of single line diagrams, engineering calculations, criteria, manufacturers' data/cut sheets, specifications, budgetary estimatesetc., suitable to provide details to remediate a facility

3.1.4 **Facility Remedial Project (FRP)**: A project undertaken to correct a situation identified from a site survey, feasibility study, or other sources.

3.1.5 **Remediation Action**: The action taken to implement a work plan; i.e., repair renovation, minor new construction.

3.2 **Data Submittal Requirements**.

3.2.1 **DD Form 1423 - Contract DATA REQUIREMENTS LIST**. These forms, attached to Section 00720 of this contract, show the frequency of submittals and the number and destination of the submittals as well as related contracting office requirements. They are referenced in the scope of work (SOW) by title and DATA ITEM NUMBER (DIN). The DIN is assigned to the data submittal requirements for the Contractor. The DIN is alpha-numeric in that it is composed of alphabetical letters and sequential data submittal requirements, numbers: i.e., FRP0001 is the first (0001) data submittal requirement for the Facilities Remediation Project

(FRP). They are cross-referenced to the scope of work and DD Form 1644 described below through common DINs titles.

3.2.2 **DD Form 1664 - DATA ITEM DESCRIPTION**. These forms, attached to Section 00720 of this contract, contain the requirements for contractor data submittals required in the SOW. Each DD Form 1664 is coded with the same alpha-numeric DIN numbers and titles as the DD Form 1423s for cross-referencing data submittal requirements, frequency of submittals, and number and destination of submittals.

4.0 **SERVICES TO BE PERFORMED**.

4.1 **General Services**: The Contractor shall, upon issuance of a task order, supply all personnel, tools, equipment, transportation, materials, and supervision (except as otherwise noted or provided) to safely and efficiently perform the FRPs. All task orders to be completed under this contract shall be performed in accordance with applicable provisions of the U.S. Army Corps of Engineers Safety and Health Requirements, Manual, EM 385-1-1; Installation Design Guides; and the Architectural and Engineering Instruction (AEI) Design Criteria, unless other criteria is provided by the Contracting Officer.

4.1.1 **Contractor's Representative**: The Contractor shall execute the work under the direction of a Contractor Project Manager approved by the Contracting Officer. The full-time on-site Project Manager shall be designated in writing (listing name, address, and local home telephone number). The Project Manager shall be responsible for the overall management and coordination of this contract and shall be the central point of contact with the Government for performance of all work under this contract including warranty. Another individual may be designated to temporarily act for the Project Manager, however, forty-eight (48) hours advance notice in writing of such change shall be provided to the Contracting Officer's Representative.

4.1.2 **Contractor's Project Manager**: The Contractor's Project Manager shall oversee task accomplishment, administer all instructions, and answer all questions from the Contracting Officer pertaining to the tasks during the life of the contract. The Contractor Project Manager shall be responsible for the complete coordination of all work under this contract. The Contractor Project Manager will be responsible for ensuring that adequate internal controls and review procedures are followed in order to eliminate conflicts, errors and omissions and for ensuring that all technical requirements are met.

4.1.3 **Overall Responsibility**: The Contractor shall be responsible for all site surveys; feasibility studies; calculations; work plans; remediation actions; equipment startups; and testing, repair, and/or training required for satisfactory completion of the FRP as required by each individual task order. This shall include, but not be limited to providing labor, equipment, materials, applicable engineering documentation, and other necessary services and/or products for the remediation, implementation, or testing that may be required by the individual task order.

4.1.4 **Codes and Standards**: The site surveys, work plans, feasibility studies, calculations, remedial actions, equipment startup and testing and/or repair shall conform to the requirements of this contract. The Contractor shall adhere to codes and standards as specified herein and in the individual task orders. All codes and standard requirements shall be based on the latest edition of codes applicable at the time the task order is issued. All work shall comply with local, state, national, or military codes, whichever most stringent.

4.1.5 **Documentation**: The Contractor shall implement, maintain, and control a system for identification, preparation, reproduction, distribution, and maintenance of all documentation, dates and information necessary for its internal management as well as for Government management of the individual projects and the total program.

4.1.6 **Presentations and Meetings**: Time and locations of presentations and meetings shall be identified in each task order.

4.1.7 **Safety and Health Program**: Site activities performed in conjunction with this program may pose safety hazards which require specialized expertise to effectively address and eliminate. The Contractor shall be responsible for preparing and implementing an effective safety and health program, to include a generic site safety and health plan prepared in accordance with DD Form 1423, DIN FRP0001. This plan shall be capable of being adapted to the sites specified in the individual task orders. Safety and Health requirements strictly for Tripler Army Medical Center are enclosed herein.

4.1.8 **Quality Control Program**: The Contractor shall develop, implement, and document an effective quality control plan for the program. The Contractor shall provide a generic site quality control plan prepared in accordance with DD Form 1423, DIN FRP0002. This generic site quality control plan shall be submitted to the Contracting Officer for approval within 30 days, or an agreed to shorter period, after contract award. The quality control plan shall be developed such that it applies to all sites and conditions specified on the individual task orders.

4.2 **Specific Services**.

4.2.1 **Permits**: The Contractor shall be responsible for identifying and obtaining all permits from Federal, State, local, or installation agencies.

4.2.2 **Interference with Installation Staff:** The Contractor may be required to work in conjunction with various installation's staff personnel. The Contractor's Project Manager shall provide a briefing to the staff prior to starting work. The briefing will provide the scope of work of the task order and a schedule for completing the work. While the Contractor is on-site, weekly coordination meetings will be conducted with the installation's points of contact. The purpose of these meetings will be to anticipate and schedule all operations where mutual effort by both groups is required.

5.0 APPROVALS, RESPONSIBILITIES, QUALIFICATIONS FOR LABOR CATEGORIES

5.1 **Staffing Approvals**: Prior to making any changes in management staff, the Contractor shall notify the Contracting Officer in writing of changes in his proposed management staff as set forth in his technical proposal.

5.1.1 The Contractor shall maintain a management staff with abilities and experience comparable to the staff listed in the management proposal. Any changes from the proposed and accepted management staff must be approved by the Contracting Officer or Representative. A request for a change to the approved staff must be submitted in writing. A current qualifications statement must be included in the request for approval.

5.1.2 Resumes that have been previously submitted to the Government need not be a part of the individual task order proposal. The Contractor shall not employ any Civil Service nor military employees to perform of any work under the contract, e.g., during off-duty hours, regular hours, or while on annual leave.

5.2 **Responsibilities**

5.2.1 **Program Manager**: This is the individual who has the direct responsibility for contract execution. This individual shall serve as the single point of contact and liaison between the Contracting Officer and the Contractor.

5.2.2 **Project Manager/Engineer**: This is the individual who has the direct responsibility for all operations on the *site*. This individual may also serve as the site safety officer and the site quality control officer if the dual roles are stated in the individual task order.

5.2.3 **Project Superintendent**: This individual will supervise the work on site as stated in each task order.

5.2.4 **Technical Staff**: The technical staff shall consist of architects and engineers(general, civil, mechanical, electrical, structural, fire protection, and safety).

5.2.5 **Quality Control Manager**: This individual shall have direct responsibility for the Quality Control Program.

5.2.5.1 **Quality Control Officer**: This individual shall have direct responsibility for the site quality control. This position may be held jointly by the project manager/engineer if the duel roles are stated in the individual task order.

5.2.6 **Safety Engineer**: This individual shall have direct responsibility for the Safety Program.

5.2.6.1 **Site Safety Officer**: This individual shall have direct responsibility for site safety. This position may be held jointly by the project manager/engineer if the dual roles are stated in the individual task order.

5.3 **Minimum Qualifications for Labor Categories**: The Contractor must possess a variety of skills in order to perform this effort. There is no limitation of the use of employees with qualifications exceeding those listed. Minimum qualification standards for labor categories are set forth in the following paragraphs.

Professional Level 1

Project Superintendent, Quality Control Manager, Quality Control Officer, Site Safety Officer, Computer System Specialist, and Engineering Support should have five-years experience in government medical facilities remediation projects. Professional must be familiar and conversant with the various codes and standards applicable to government medical facilities remediation tasks covered under this scope of work.

Professional Level 2

Architectural, Engineering, Cost Estimator,ComputerSpecialist, Safety Engineer, Industrial Hygienist, Biologist, Environmentalist, and Agronomist. Shall have a recognized four-year college degree in architecture/engineering (or related technical fields); seven-years of design/engineering or service experience (in unique discipline) for government medical remediation projects. The Architect and Engineers shall be registered professionals in their respective disciplines. Professional must be familiar and conversant with the various codes and standards applicable to government medical remediation tasks covered under this scope of work.

Professional Level 3

Project Manager/Engineer - Must have a recognized four-year degree in engineering, or ten-years experience in engineering or construction of government medical facilities. Professional(s) must be familiar and conversant with the various codes and standards applicable to government medical facility remediation tasks covered by the scope of work.

Professional Level 4

Program Managers - Must have a recognized four-year college degree in engineering or related technical field or business/management, or ten-years experience in managing and supervising government medical remediation projects. Professional(s) must be familiar and conversant with the various codes and standards applicable to facility government medical remediation tasks covered by the scope of work.

Professional Level 5

Surveyor **-** Must have a minimum of five years experience in surveying; registered professional land surveyor; and service experience in government medical remediation projects. Surveyor must be familiar and conversant with sewer line surveying, centerline road profile surveying, drainage surveying, and other surveying tasks covered by the scope of work.

6.0 **ACTIVITIES UNDER FACILITY REMEDIATION PROJECTS**.

6.1 **Task Orders**: The activities to be performed by the Contractor under this contract and subsequent task orders are described in general terms below (this list is not all inclusive). The specific tasks to be performed will be identified in each task order. The Contracting Officer or Ordering Officer reserves the right to modify duties and time periods in the task. At the completion of each approved task order, the results, documented and conceptual, becomes the property of the Government. The Contracting Officer shall decide whether additional task orders shall be executed.

6.1.1 **Site Survey Proposal**. Upon request by the Contracting Officer or Ordering Officer, a site survey proposal shall be submitted by the Contractor in accordance with DD Form 1423, DIN FRP0003.

6.1.2 **Site Survey**. Within 5 working days after the acceptance of, the Site Survey Proposal by the Contracting Officer or Ordering Officer, the contractor shall start a site survey in accordance with DD Form 1423, DIN FRP0004.

6.1.3 **Site Survey Report**. Within 10 working days after conclusion of the site visit, the contractor shall prepare and submit to the Contracting Officer or Ordering Officer, a site survey report in accordance with DD Form 1423, DIN FRP0005.

6.1.4 **Feasibility Study**. When the results of the site survey report justifies(in the opinion of the Contracting Officer or Ordering Officer) a feasibility study, the contractor shall perform a feasibility study based on the findings of the site survey report in accordance with DD Form 1423, FRP0006. The feasibility study shall be submitted within 10 working days after requested by the Contracting Officer unless otherwise stated on the task order.

6.1.5 **Work Plan**. Subsequent to award of the Work Plan Task Order, the Contractor shall prepare and submit a work plan to the Contracting Officer or Ordering Officer for approval prior to beginning any remedial action. The work plan shall be submitted for two reviews, preliminary and final, in accordance with DD Form 1423, DIN FRP0007. Work Plan (Contractor's technical requirements) shall be submitted within time specified on the Task Order. The Contracting Officer may accept the preliminary work plan or direct the contractor to continue through the final submittal. The final review will ensure all Government review comments from the preliminary submittal have been incorporated.

6.1.6 **Negotiations for Construction Task Order**. The negotiations, if required, between the Contracting Officer, Ordering Officer, or Contracting Officer's Authorized Representative and the Contractor, shall be conducted at a date and time determined by the Government. Details covered shall include, but not necessarily be limited to:

Scope of Work Plan.
Period of Contract.
Technical Details of Work Plan.

Management of Work Plan.
Cost of Price Proposal (FRP0008).

The Contractor shall not commence with the task order remediation action until all items above have been discussed/negotiated and a task order awarded, unless the task order has been issued as a time and materials task order.

6.1.7 After the remedial action has been awarded (through the medium of a task order) the contractor shall:

6.1.7.1 Attend a pre-remediation conference with the Contracting Officer's Authorized Representative for review of the items described in DD Form 1423, DIN FRP0009.

6.1.7.2 Begin work on the remediation of the facility in accordance with the approved work plan following the approved work schedule. As work progresses, the contractor shall meet the following requirements:

a. Adhere to the approved plan for site safety and health, prepared and submitted in accordance with DD Form 1423, FRP0001 and as modified by the task order.

b. Adhere to the approved quality control program, prepared and submitted in accordance with DD Form 1423, DIN FRP0002 and as modified by the task order.

c. Prepare and certify a comprehensive work, schedule based on the proposed work plan in accordance with DD Form 1423, FRP0010.

d. Remediate the facility in accordance with the work plan previously submitted and signed-off on in DD Form 1423, DIN FRP0007.

e. Submit weekly progress reports starting second week after issuance of task order in accordance with DD Form 1423, DIN FRP0011.

f. Maintain a telephone correspondence log in accordance with DD Form 1423, DIN FRP0012.

g. Conduct test of modified system/equipment and obtain Government inspection/approval in accordance with DD Form 1423, DIN FRP0013.

h. Prepare operation and maintenance manuals, for the modified system/equipment in accordance with DD from 1423, DIN FRP0014.

i. Prepare training program and train Government personnel in operation and maintenance of modified system/equipment in accordance with DD Form 1423, DIN FRP0015.

j. Provide equipment and construction warranties in accordance with DD Form 1423, DIN FRP0016.

k. Submit certified list of standard equipment and MFRP service organizations in accordance with DD Form 1423, DIN FRP0017.

l. Certify computer media in accordance with DD Form 1423, DIN FRP0018.

m. Prepare and submit project specific remediation reports including "lessons learned" documents in accordance with DD Form 1423, DIN FRP0019.

6.1.8 **As-Built Drawings**. As the work progresses, the contractor shall maintain redline as-built drawings, which reflects the status of the project in accordance with DD Form 1423, DIN FRP0020. At the completion of the project, the contractor shall submit final as-built drawings in accordance with DD Form 1423, DIN FRP0021.

6.1.9 **Survey Log Books and Survey Drawings.** Contractor shall provide survey log books and survey drawings as required in DD Form 1423, DIN FRP022.

7.0 **SUBMITTED SURVEYS, STUDIES, PROPOSALS, AND WORK PLANS**. All surveys, studies, proposals, and work plans submitted to the Contracting Officer or Ordering Officer shall become the property of the Government.

8.0 **ENVIRONMENTAL PROTECTION**. The contractor shall perform all work in such a manner as to minimize the pollution of air, water, or land and to control noise and dust within reasonable limits and in accordance with federal, state, and local environmental laws.

8.1 **Smoking Policy.** There will be no smoking within the facility. If approved by the facility manager, a smoking area may be designated a minimum of 50 feet away from the facility and all stockpiles of materials.

9.0 **ASBESTOS AND/OR LEAD-BASED PAINT ABATEMENT (REMOVAL OR ENCAPSULATION).** When work is in areas suspected of containing asbestos, OSHA Standard 29 CFR 1910.1001 shall apply. OSHA Standard 29 CFR 1926.1101 requires that asbestos be presumed to be present in all facilities constructed before 1980. Under this standard, where insulating or surfacing materials cannot be identified not to be or to contain asbestos, they will be assumed to be or contain asbestos with appropriate safety procedures taken. The contractor shall, when tasked to do so in the task order, perform this determination as well as carry out the resultant abatement. The provisions of OSHA Standard 1926.22 shall apply to the abatement of lead-based paint. The Contractor shall identify and abate lead-based paint when tasked to do so by the task order.

10.0 **SITE SECURITY**. The contractor shall provide site security (fencing, lighting, or guard services) as required by each task order. However, at a minimum, the contractor shall maintain the site and all other contractor controlled areas in such a manner as to minimize the risk of theft, vandalism, injury, or accident. The contractor shall comply with site security regulations.

11.0 **ACCIDENT REPORTS**. The contractor shall comply with accident reporting requirements as outlined in the U.S. Army Corps of Engineers, Safety and Heath Requirements Manual EM 385-1-1, which will be furnished by the Contracting Officer. All accident reports shall be submitted to the Contracting Officer or Ordering Officer within the time limits prescribed.

12.0 **PUBLIC AFFAIRS**. The contractor shall not publicly disclose any data generated or reviewed under this contract. The contractor shall refer all request for information concerning site conditions to the Contracting Officer or Ordering Officer for comment.

13.0 **REFERENCES**. The publications listed below form the basis for the remediation work under this contract. Additional references may be identified as required in task orders. Work done under individual task orders shall utilize the latest issue of the publication dated at the time of award of the task order. When a required publication is not referenced in this list or the task order, the contractor shall utilize one that has national applications. Where conflicts arise between publications, the most stringent shall apply.

13.1 American Hospital Association (AHA)

AHA	Maintenance Management for Health Care Facilities

13.2 American National Standards Institute (ANSI):

ANSI C2	National Electric Safety Code

13.3 American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE):

Handbooks	Refrigeration Fundamentals HVAC System and Equipment HVAC Applications
Standards	Ventilation for Acceptable Indoor Air Quality

13.4 Installation Design Guides

13.5 Code of Federal Regulations (CFR):

29 CFR 1910	Occupational Safety and Health Standards - General Construction
29 CFR 1926	Occupational Safety and Health Standards - Construction Industry

13.6 Department of the Army, Corps of Engineers Manual (EM):

EM 385-1-1	Safety and Health Requirements Manual

13.7 Department of the Army, Corps of Engineers Regulation (ER):

ER 25-345-1	Military Publications System Operation and Maintenance Documentation

13.8 Department of the Army Regulation (AR):

AR 385-40	Accident Reporting Standards

13.9 Department of the Army Technical Manuals (TM):

TM 5-810-1	Mechanical Design, Heating, Ventilating, and Air Conditioning
TM 5-810-4	Compressed Air
TM 5-810-5	Plumbing
TM 5-811-1	Electric Power Supply and Distribution
TM 5-811-2	Electric Design, Interior Electrical System
TM 5-811-14	Coordinated Power Systems Protection
TM 5-815-3	Heating, Ventilation, and Air Conditioning (HVAC)

13.10 Joint Commission Accreditation on Health Care Organization (JCAHO):

JCAHO	Joint Commission of Accreditation on Health Care OrganizationsMilitary

13.11 Handbooks (MIL-HDBK):

MIL-HDBK-1008C	Fire Protection for Facilities Engineering, Design, and Construction
MIL-HDBK-1190	Facility Planning and Design Guide

13.12 National Institute of Technology and Standards

Handbook 135	Life Cycle Cost Analysis

13.13 National Fire Protection Association, Inc. (NFPA):

NFPA 70	National Electric Code
NFPA 80	Doors and Windows
NFPA 99	Health Care Facilities
NFPA 101	Safety to Life from Fire in Building and Structures

13.14 Building Codes (52.9101-4000 TM)

All work shall be performed in compliance with the following National Standards and Codes, applicable.

American Institute of Steel Construction (AISC)

American Concrete Institute (ACI)

Uniform Building Code (UBC)

Uniform Plumbing Code (UPC)

Uniform Mechanical Code (UMC)

Code of Federal Regulations (CFR)

OSHA General Industry Safety and Health Standards (29 CFR 1910), Publication V2206; and OSHA Construction Industry Standards (29 CFR 1926). One source of these regulations is OSHA Publication 2207, which includes a combination of both Parts 1910 and 1926 as they relate to construction safety and health. Contact the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

National Emission Standards for Hazardous Air Pollutants (40 CFR, Part 61).

Federal Standard (Fed. Std. 313A, Material Safety Data sheets, Preparation and the Submission).

13.15 Federal Standard 795, Uniform Federal Accessibility Standards.

13.16 American Disability Act (ADA).

13.17 Installation Interior/Exterior Architectural Plans, USAG-HI.

14.0 **MEDICAL TREATMENT FACILITES.** This contract shall apply to all Government medical and other facilities in the US Army Corps of

Engineers, Honolulu District, Area of Responsibility (AOR), (excluding Alaska and Korea).

Tripler Army Medical Center, Honolulu, Hawaii
Schofield Barracks Health Clinic, Wahiawa, Hawaii
Dispensaries (2) - Pohakuloa Training Area and Military Camp, Island of Hawaii, Hawaii
Veterinary Treatment Facilities (4) - Territory of Guam; Ft. Shafter, Hawaii; Hickam Air Force Base, Hawaii; and Schofield Barracks, Hawaii

----- END OF SECTION 01000-----

PREVENTION GUIDE AND RESPONSIBILITIES FOR CONTRACTORS

These accident prevention guidelines are for the use by contractors and subcontractors who perform work on TRIPLER owned or occupied facilities. The rules and practices set forth here are those that have broad application, and it will be necessary to supplement them with additional rules specific to any particular job. Each job, regardless of the type of work involved will present problems that will call for special consideration and methods. Any time a new or different hazard arises, the contractor and project engineer shall review the situation and establish additional rules that will minimize the risks. Our purpose for presenting these guidelines is to help you work safely and to assure a safe place of work for all. For further clarification or counsel, contract the Tripler Safety and Occupational Health Manager at 433—6078.

Project Name: ______________________________

Project Number: ______________________________

Project Location: ______________________________

Other areas immediately affected: ______________________________

Start Date: ____________________ Completed Date: ______________________________

Facilities Management Branch Contact ______________________________

Contract Office Representative ______________________________

Contractor Company ______________________________

Preconstruction Conference Date: ______________________________

ACCIDENT PREVENTION GUIDE AND RESPONSIBILITIES FOR CONTRACTORS

A. General Requirements

1. Contractors will comply with OSHA Standard 29 CFR 1926 construction standards, and the portions of OSHA 29 CFR 1910 General industry standards that are applicable. The Army Corps of Engineers Manual, EM 385-1 (latest edition) will be used in the absence of guidance in OSHA standards. The Life Safety Measures from the Joint Commission on Accreditation Manual for Hospitals, NFPA and other applicable Army and TAMC standards will also be used and implemented.

2. Responsibility for providing safe and healthful working conditions rests with the contractor.

3. The contractor must appoint a safety representative from among employees on the job who can act in the contractor's absence.

4. It is the contractor's prime responsibility to insure that any sub—contractor shall comply with, and receive a copy of the accident prevention checklist.

5. The contractor shall be responsible for providing an adequate number of fire extinguishers for the work site.

6. Horseplay, drinking of alcoholic beverages, the illegal use of drugs and no smoking in the Hospital at all or failure to follow safety regulations may be grounds to insist upon removal of the involved individual from TAMC grounds.

7. Prior to the initial start of construction, all contractors will visit the work site and identify and document all hazards inherent in and around the work site area; i.e., overhead power lines, underground cables, unusual topography, parking lot, etc. The contractor will convey this information to his employees and assure that special considerations are taken when working around these hazards. The contractor shall comply with any specific regulations that apply to work in dangerous or potentially dangerous areas.

8. The contractor is responsible for requiring employees to wear appropriate personal protective equipment; i.e., safety toed footwear, hard hats, safety glasses, where there is an exposure to hazardous conditions.

9. Both DOL and State of Hawaii OSHA inspectors are authorized right of entry to inspect any place of employment operated by Army contractors. They are for the most part "no notice" inspections.

10. If a contractor is cited for an OSHA violation involving government furnished equipment, response to the citation shall still be his responsibility.

11. In case of any medical emergency or accident which involves injury to a contractor employee, emergency medical services are available at Tripler Army Medical Center, Bldg.1 Telephone No. 433-7117. This is at the contractors option. Routine and non-emergency medical treatment is not provided to contractor employees at TAMC.

12. It is the responsibility of the contractor to perform daily housekeeping around the immediate job site.

ACCIDENT PREVENTION GUIDE AND RESPONSIBILITIES FOR CONTRACTORS

13. Before any action is taken which will impact the flow of traffic around the job site, it must be coordinated with the Security Police and Safety through the Logistics Division It is the responsibility of the contractor to provide proper safety features as needed; i.e., flagmen in order to regulate traffic, proper barricades, lighting, vehicle check front and back prior to moving, and caution signs around work area.

14. In case of an accident involving damage to government property or other event that may effect patient safety promptly report the problem to the information desk at 433-7117. It is the contractors responsibility to ensure that as a minimum the COR, Logistic Division, Security and the Safety Office are all notified.

15. When planning for the size, configuration, and equipping the space JCAHO requires to be used *Guidelines for design and construction of hospital and health care facilities* by the American Institute of Architects, applicable state and federal rules and regulation or similar standards or guidelines as outlined in the JCAHO manual.

16. No hot work will be performed without first securing a "Burn Permit" from the Federal Fire Department. Additionally, contact the FFD for additional requirments.

17. Contractor employees shall comply with all traffic control and parking regulations while operating on TAMC reservation.

B. Specific Requirements

1. Smoking is not allowed inside Tripler. Only outside 50 feet from the building or in designated smoking areas.

2. Openings in smoke/ fire walls, floors, ceilings, partitions for the passage of conduit, piping, cables etc. are required to have fire-resisting and smoke resisting capability in accordance with NFPA 101 chapter 6.

3. Fire stop material must be installed in accordance with manufacture's specifications.

4. Holes and penetrations must be fire stopped as the holes and penetrations are made and not be done at the end of the week, month, project etc.

5. Two weeks notice shall be given to Facilities Management Branch and Tripler Safety Office prior to impairment of sprinkler, fire alarm or other fire protection system if systems are to be worked on or disconnected.

6. Fire detection, alarm and extinguishing systems shall not be relocated, removed or disconnected without prior written notification to the Safety Office

7. Smoke detectors, heat detectors and sprinklers shall not be covered or bagged by contractors. Facilities Management Branch shall be notified for proper disconnects of detectors when warranted.

8. The fire alarm/extinguisher system shall be restored to full operation upon completion of the workday or during extended breaks and on days when work will not be performed (i.e. weekends, holidays, and evenings).

ACCIDENT PREVENTION GUIDE AND RESPONSIBILITIES FOR CONTRACTORS

9. Fire alarm/extinguisher systems (smoke detectors, heat sensors, fire dampers, alarm devices, sprinklers, fire extinguishers, pull stations, etc) cannot be covered, disconnected, removed or tampered without the prior written approval from the Tripler Safety Manager.

10. The Federal Fire Department and Safety Office must be notified and a fire watch provided whenever an approved fire alarm, automatic sprinkler system or fire protection system is out of service for more than four hours in a 24-hour period or as required by the AHJ.

11. If written approval is granted, the Tripler Safety Manager, Information Desk, Facility Management Branch and Federal Fire Department shall be notified just prior to the actual disconnect, removal or tampering and upon restoration of the fire alarm/extinguisher system.

12. A hot work permit is required to be issued by the Federal Fire Department prior to all hot work to include tar kettles and torch application.

13. Dust control barriers shall be non-combustible. (Exception: Fire retardant plastic sheeting may be used in limited application with the prior written consent of the Safety Office)

14. In case of an actual fire alarm activation or fire drill, contractors are required as a minimum to clear corridors of equipment and proceed to the nearest exit until the all clear is given.

15. Flammables shall not be stored on site unless in an approved flammable storage locker per NFPA and 29 CFR 1910.

16. Tripler's emergency power and emergency electrical receptacles (color coded yellow) will not be used by the contractor.

17. Visitors and staff must be protected from the vapors and health effects of the products being used and removed.

18. Doors may not be wedged or held open with devices or items.

19. The Safety Manager and his designee is authorized to intervene whenever conditions exist that pose an immediate threat to life or health or pose a threat of damage to equipment or buildings

SECTION 01045 - ALTERATIONS TO EXISTING BUILDING(S)

PART 1 - GENERAL

1.1 SUMMARY
This section covers alterations to existing building(s), complete.

PART 2 - PRODUCTS

2.1 GENERAL
Materials and equipment required for repair or alterations of, or additions to, existing building(s) shall be as specified in the applicable technical sections in Divisions 2 through 16 of the Task Order specifications.

PART 3 - EXECUTION

3.1 GENERAL

Task Orders will indicate the extent and requirements of the alterations and additions to the existing buildings. If any departures from the Task Orders or from the contract documents are deemed necessary by the Contractor, details of such departures and the reasons therefor shall be submitted as soon as possible to the Contracting Officer for action. No such departures shall be made without prior written approval of the Contracting officer.

3.1.1 Roads and Public Areas

Roads and other public areas within the work areas shall be kept clean of construction debris at all times.

3.1.2 Protection

During non-working hours and periods of inclement weather, the Contractor shall cover and secure all exposed openings. Buildings shall not be left overnight without sufficient protection against the elements.

3.1.3 Roofing Work

When work is required on a roof, the Contractor shall protect the existing roof surfaces, including flashings, from damage resulting from roof traffic and work operations. The Contractor shall maintain the roof in a waterproof condition. Where wheeled or foot traffic over the roof is unavoidable, provide and use adequate plank, plywood, or other protection for the roof. Wheeled vehicles shall be mounted on pneumatic-tired wheels, and shall be designed and maintained to operate without damaging the roofing membrane or the insulation or deck underneath. Roof traffic on metal roofs shall be in accordance with the recommendations of the metal roof manufacturer.

3.2 REMOVAL

Unless otherwise specified and insofar as is practicable, items and materials shall be removed in a manner inverse to that used in the placing of the, items and materials in the structures. Care shall be taken during removal operations to prevent any unnecessary damage to the building. Any unnecessary damage to the buildings resulting from the Contractor's operations shall be repaired at the expense of the Contractor and to the satisfaction of the Contracting Officer. Equipment to be reinstalled shall be reinstalled after work called for under other sections of these specifications has been completed. All items which are to be removed and then reinstalled shall be carefully removed and protected until reinstalled.

3.3 PAINTING AND FINISHING

Existing surfaces where items and materials were removed shall be repaired and painted to match the adjoining surfaces. Surfaces remodeled shall be painted to match the adjoining surfaces. All new surfaces where specified or required to be painted shall be painted. Existing painted surfaces which are damaged by work under this contract shall be repaired to original condition and then repainted with one coat of paint to match adjacent surfaces. Where an existing painted wall or ceiling has been repaired or patched with new materials, the entire wall or ceiling containing the repaired portion shall be repainted as follows: The repaired portion shall be painted to effect complete hiding and to blend with the adjacent surfaces, and then the entire wall or ceiling given one coat of paint. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations of color, texture, and finish. Painting shall conform to the requirement of Section 09900 PAINTING, GENERAL.

3.4 ALTERATIONS

Alterations to the structures shall be in accordance with the arrangement indicated on the Task Orders and as approved by the Contracting Officer. All alterations shall be performed by workmen skilled in the work and in accordance with the best standard practices of the trades involved. All work shall be performed in accordance with the requirements for new work as specified under the specification sections required by the Task Orders.

3.5 SALVAGE MATERIALS AND EQUIPMENT

3.5.1 Property Control Records

The Contractor shall maintain adequate property control records for all materials or equipment specified to be salvaged. These records may be in accordance with the Contractor's system of property control, if approved by the property administrator. The Contractor shall be responsible for the adequate storage and protection of all salvaged materials and equipment and shall replace, at no cost to the Government, all salvage materials and equipment which are broken or damaged during salvage operations as the result of his negligence, or while in his care.

3.5.2 Title To Scrap and Salvage

In consideration for credit allowed in the contract price, the title to all scrap and salvage generated as a direct result of this contract is vested in the Contractor unless specifically excepted. The scrap and salvage shall be disposed of off the Base by the Contractor.

3.6 DISPOSAL

Rubble, scrap and all other debris shall be removed and disposed of by the Contractor as approved by the Contracting Officer. Upon completion of the work for any Task Order, all staging, scaffolding, and containers shall be removed from the site or destroyed as approved. Paint spots, oil or stains upon surfaces shall be removed, the entire (Task Order) job site left clean and acceptable to the Contracting Officer.

-- End of Section --

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DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01090

SOURCES FOR REFERENCE PUBLICATIONS

06/99

PART 1 GENERAL

1.1 REFERENCES
1.2 ORDERING INFORMATION

-- End of Section Table of Contents --

****
DEPARTMENT OF THE ARMY **CEGS-01090 (September 1999)**
U.S. ARMY CORPS OF ENGINEERS **---------------------------**
Superseding
CEGS-01090 (June 1999)

GUIDE SPECIFICATION FOR CONSTRUCTION
****

SECTION 01090

SOURCES FOR REFERENCE PUBLICATIONS
06/99

****
NOTE: This guide specification provides a listing of organizations whose publications are referenced in other sections of the specifications. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the sponsoring organization, e.g. UL 1 (1993; Rev thru Jan 1995) Flexible Metal Conduit. However, when the sponsoring organization has not assigned a number to a document, an identifying number has been assigned for convenience, e.g. UL's unnumbered 1995 edition of their Building Materials Directory is identified as UL-01 (1995) Building Materials Directory. The sponsoring organization number (UL 1) can be distinguished from an assigned identifying number (UL-01) by the lack of a dash mark (-) in the sponsoring organization assigned number.

1.2 ORDERING INFORMATION

****
NOTE: Sponsoring organization information was current as of the date of this section.

This paragraph is automatically edited to fit the project when the project specifications are produced through SPECSINTACT; however, if publications of organizations in addition to those listed below are used in the project, such additional organizations must be added to this paragraph.
****

The addresses of the organizations whose publications are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided. Documents listed in the specifications with numbers which were not assigned by the sponsoring organization should be ordered from the source by title rather than by number.

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Ph: 214-243-3902
Fax: 214-243-3907

U. S. ARMY ENVIORNMENTAL HYGIENE AGENCY (USAEHA)

Waste Disposal Engineering Division
Aberdeen Proving Ground, MD 21010-5422
Ph: 410-671-3652

WATER ENVIRONMENT FEDERATION (WEF)

601 Wythe St.
Alexandria, VA 22314-1994
Ph: 703-684-2400
Fax: 703-684-2492
Internet: www.wef.org

WATER QUALITY ASSOCIATION (WQA)

4151 Naperville Rd.
Lisle, IL 60532
Ph: 630-505-0160
Fax: 630-505-9637

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

P.O. Box 23145
Portland, OR 97281
Ph: 503-639-0651
Fax: 503-684-8928

WESTERN WOOD PRESERVERS INSTITUTE (WWPI)

7017 N.E. Highway 99 # 108
Vancover, WA 98666
Ph: 360-693-9958
Fax: 360-693-9967

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

Yeon Bldg.
522 SW 5th Ave.
Portland, OR 97204-2122
Ph: 503-224-3930
Fax: 503-224-3934

WOOD MOULDING AND MILLWORK PRODUCERS ASSOCIATION (WMMPA)

507 First Street
Woodland, CA 95695
Ph: 916-661-9591
Fax: 916-661-9586

-- End of Section --

SECTION 01200 - PROJECT MEETINGS

PART I - GENERAL

1.1 PRECONSTRUCTION CONFERENCE

After award of the construction Task Order and prior to the start of any construction work an authorized representative of the Contracting Officer will schedule and conduct a preconstruction conference. The Contractor's Project Manager, Superintendent and Quality Control Manager will attend this meeting. The Contractor is encouraged to have an officer of his company and representation from his sub-contractors at this conference. This conference will be held at the location specified by the Contracting Officer's authorized representative.

1.1.1 Commencement of Construction Work

If the Contractor has submitted his Accident Prevention (safety) Plan, Quality control Plan, and Environmental Protection Plan for review prior to the preconstruction conference, these Plans may be accepted in its entirety or accepted with comments discussed at the conference. The Contractor shall not proceed with the construction work until after the preconstruction conference is held, the three Plans stated above have been accepted, and the Notice to Proceed(NTP) has been received from the Government and acknowledged by the Contractor.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

-- End of Section --

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DEPARTMENT OF THE ARMY | **HED-01320 (June 1998)**
U.S. ARMY CORPS OF ENGINEERS | **--------------------------**
Superseding
CEGS-01310 (December 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

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DEPARTMENT OF THE ARMY **HED-01320 (June 1998)**
U.S. ARMY CORPS OF ENGINEERS **--------------------------**
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CEGS-01310 (December 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 01320

PROJECT SCHEDULE
06/97

****
NOTE: This guide specification covers the requirements for the preparation and maintenance of the project schedule. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-700.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: Selection of the optional requirements in this CEGS should be coordinated with Construction Division to ensure that the schedule requirements are appropriate for the complexity of the constructability portion of the BCOE review. See ER 415-1-11. Paragraphs may not be removed from this specification except as noted.

If it is desired to monitor a Contractor's schedule by use of an in-house program, this will require use of the Standard Data Exchange Format. Use of proprietary systems shall not be specified. See ER 1-1-11 and Appendix.
****

1.1 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-07 Schedules

Preliminary Project Schedule; GA.
Initial Project Schedule; GA.
Periodic Schedule Updates; GA.

Two copies of the schedules showing codes, values, categories, numbers, items, etc., as required.

SD-08 Statements

Qualifications; GA.

Documentation showing qualifications of personnel preparing schedule reports.

SD-09 Reports

Narrative Report; FIO.
Schedule Reports; FIO.

Two copies of the reports showing numbers, descriptions, dates, float, starts, finishes, durations, sequences, etc., as required.

1.2 QUALIFICATIONS

The Contractor shall designate an authorized representative who shall be responsible for the preparation of all required project schedule reports. This person shall have previously created and reviewed computerized schedules. Qualifications of this individual shall be submitted to the Contracting Officer for review with the Preliminary Project Schedule submission

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL

Pursuant to the Contract Clause, SCHEDULE FOR CONSTRUCTION CONTRACTS, a Project Schedule as described below shall be prepared. The scheduling of construction shall be the responsibility of the Contractor. Contractor management personnel shall actively participate in its development. Subcontractors and suppliers working on the project shall also contribute in developing and maintaining an accurate Project Schedule. The approved Project Schedule shall be used to measure the progress of the work, to aid in evaluating time extensions, and to provide the basis of all progress payments.

3.2 BASIS FOR PAYMENT

The schedule shall be the basis for measuring Contractor progress. Lack of an approved schedule or scheduling personnel shall result in an inability of the Contracting Officer to evaluate Contractor progress for the purposes of payment. Failure of the Contractor to provide all information, as specified below, shall result in the disapproval of the entire Project Schedule submission and the inability of the Contracting Officer to evaluate Contractor progress for payment purposes. In the case where Project Schedule revisions have been directed by the Contracting Officer and those revisions have not been included in the Project Schedule, then the Contracting Officer may hold retainage up to the maximum allowed by contract, each payment period, until revisions to the Project Schedule have been made.

3.3 PROJECT SCHEDULE

The computer software system utilized by the Contractor to produce the Project Schedule shall be capable of providing all requirements of this specification. Failure of the Contractor to meet the requirements of this specification shall result in the disapproval of the schedule. Manual methods used to produce any required information shall require approval by the Contracting Officer.

3.3.1 Use of the Critical Path Method

The Critical Path Method (CPM) of network calculation shall be used to generate the Project Schedule. The Contractor shall provide the Project Schedule in either the Precedence Diagram Method (PDM) or the Arrow Diagram Method (ADM).

3.3.2 Level of Detail Required

With the exception of the preliminary schedule submission, the Project Schedule shall include an appropriate level of detail. Failure to develop or update the Project Schedule or provide data to the Contracting Officer at the appropriate level of detail, as specified by the Contracting Officer, shall result in the disapproval of the schedule. The Contracting Officer will use, but is not limited to, the following conditions to determine the appropriate level of detail to be used in the Project Schedule.

3.3.2.1 Activity Durations

Contractor submissions shall follow the direction of the Contracting Officer regarding reasonable activity durations. Reasonable durations are those that allow the progress of activities to be accurately determined between payment periods (usually less than 2 percent of all non-procurement activities' Original Durations shall be greater than 20 days).

3.3.2.2   Procurement Activities

Tasks related to the procurement of long lead materials or equipment shall be included as separate activities in the project schedule. Long lead materials and equipment are those materials that have a procurement cycle of over 90 days. Examples of procurement process activities include, but are not limited to: submittals, approvals, procurement, fabrication, delivery, installation, start-up, and testing.

3.3.2.3   Government Activities

Government and other agency activities that could impact progress shall be shown. These activities include, but are not limited to: approvals, inspections, utility tie-in, Government Furnished Equipment (GFE) and notice to proceed for phasing requirements.

3.3.2.4   Bid Item

All activities shall be identified in the project schedule by the Bid Item to which the activity belongs. An activity shall not contain work in more than one bid item. The bid item for each appropriate activity shall be identified by the Bid Item Code.

3.3.2.5   Feature of Work

All activities shall be identified in the project schedule according to the feature of work to which the activity belongs. Feature of work refers, but is not limited to a work breakdown structure for the project. The feature of work for each activity shall be identified by the Feature of Work Code.

3.3.3   Scheduled Project Completion

The schedule interval shall extend from notice-to-proceed to the contract completion date.

3.3.3.1   Project Start Date

****
NOTE: Delete last two sentences if not necessary.
****

The schedule shall start no earlier than the date that the Notice to Proceed (NTP) was acknowledged. The Contractor shall include as the first activity in the project schedule an activity called "Start Project". The "Start Project" activity shall have: a "ES" constraint, a constraint date equal to the date that the NTP was acknowledged, and a zero day duration.

3.3.3.2   Constraint of Last Activity

****
NOTE: Delete last two sentences if not necessary.
****

Completion of the last activity in the schedule shall be constrained by the contract completion date. Calculation on project updates shall be such that if the early finish of the last activity falls after the contract completion date, then the float calculation shall reflect a negative float on the critical path. The Contractor shall include as the last activity in the project schedule an activity called "End Project". The "End Project" activity shall have: a "LF" constraint, a constraint date equal to the completion date for the project, and a zero day duration.

3.3.3.3 Early Project Completion

In the event the project schedule shows completion of the project prior to the contract completion date, the Contractor shall identify those activities that have been accelerated and/or those activities that are scheduled in parallel to support the Contractor's "early" completion. Contractor shall specifically address each of the activities noted at every project schedule update period to assist the Contracting Officer in evaluating the Contractor's ability to actually complete prior to the contract period.

3.3.4 Interim Completion Dates

Contractually specified interim completion dates shall also be constrained to show negative float if the early finish date of the last activity in that phase falls after the interim completion date.

3.3.5 Default Progress Data Disallowed

Actual Start and Finish dates shall not be automatically updated by default mechanisms that may be included in CPM scheduling software systems. Actual Start and Finish dates on the CPM schedule shall match those dates provided from Contractor Quality Control Reports. Failure of the Contractor to document the Actual Start and Finish dates on the Daily Quality Control report for every in-progress or completed activity and ensure that the data contained on the Daily Quality Control reports is the sole basis for schedule updating shall result in the disapproval of the Contractor's schedule and the inability of the Contracting Officer to evaluate Contractor progress for payment purposes.

3.3.6 Out-of-Sequence Progress

Activities that have posted progress without predecessors being completed (Out-of-Sequence Progress) will be allowed only on a case-by-case approval of the Contracting Officer. The Contracting Officer may direct that changes in schedule logic be made to correct any or all out-of-sequence work.

3.3.7 Extended Non-Work Periods

****
NOTE: Delete this paragraph if not necessary.
****

Designation of Holidays to account for non-work periods of over 5 days will not be allowed. Non-work periods of over 5 days shall be identified by addition of activities that represent the delays. Modifications to the logic of the project schedule shall be made to link those activities that may have been impacted by the delays to the newly added delay activities.

3.3.8 Negative Lags

Lag durations contained in the project schedule shall not have a negative value.

3.4 PROJECT SCHEDULE SUBMISSIONS

The Contractor shall provide the submissions as described below. The data disk, reports, and network diagrams required for each submission are contained in paragraph SUBMISSION REQUIREMENTS.

3.4.1 Preliminary Project Schedule Submission

The Preliminary Project Schedule, defining the Contractor's planned operations for the first 90 calendar days shall be submitted for approval within 20 calendar days after Notice to Proceed is acknowledged. The approved preliminary schedule shall be used for payment purposes not to exceed 90 calendar days after Notice to Proceed.

3.4.2 Initial Project Schedule Submission

The Initial Project Schedule shall be submitted for approval within 60 calendar days after Notice to Proceed. The schedule shall provide a reasonable sequence of activities which represent work through the entire project and shall be at a reasonable level of detail.

3.4.3 Periodic Schedule Updates

Based on the result of progress meetings, specified in "Periodic Progress Meetings," the Contractor shall submit periodic schedule updates. These submissions shall enable the Contracting Officer or to assess Contractor's progress. If the Contractor fails or refuses to furnish the information and project schedule data, which in the judgement of the Contracting Officer or authorized representative, is necessary for verifying the contractor's progress, the Contractor shall be deemed not to have provided an estimate upon which progress payment may be made.

3.5 SUBMISSION REQUIREMENTS

The following items shall be submitted by the Contractor for the initial submission, and every periodic project schedule update throughout the life of the project:

3.5.1 Data Disks

One data disk or one set of data disks containing the project schedule shall be provided. Data on the disks shall be in the P3 format or other format which conforms to the format specified in the attached Standard Data Exchange Format specification (attached at the end of this Project Schedule specification.

3.5.1.1 File Medium

Required data shall be submitted on 3.5-inch disks, formatted to hold 1.44 MB of data, under the MS-Windows operating system.

3.5.1.2 Disk Label

A permanent exterior label shall be affixed to each disk submitted. The label shall indicate the type of schedule (Initial, Update, or Change), full contract number, project name, project location, data date, name and telephone number or person responsible for the schedule, and the operating system and version used to format the disk.

3.5.1.3 File Name

****
NOTE: Delete this paragraph if not necessary.
****

Each file submitted shall have a name related to either the schedule data date, project name, or contract number. The Contractor shall develop a naming convention that will ensure that the names of the files submitted are unique. The Contractor shall submit the file naming convention to the Contracting Officer for approval.

3.5.2 Narrative Report

A Narrative Report shall be provided with each update of the project schedule. This report shall be provided as the basis of the Contractor's progress payment request. The Narrative Report shall include: a description of activities along the critical path(s), a description of current and anticipated problem areas or delaying factors and their impact, and an explanation of corrective actions taken.

3.5.3 Approved Changes Verification

Only project schedule changes that have been previously approved by the Contracting Officer shall be included in the schedule submission. The Narrative Report shall specifically reference, on an activity by activity basis, all changes made since the previous period and relate each change to documented, approved schedule changes.

3.5.4 Schedule Reports

The format for each activity for the schedule reports listed below shall contain: Activity Numbers, Activity Description, Original Duration, Remaining Duration, Early Start Date, Early Finish Date, Late Start Date, Late Finish Date, Total Float. Actual Start and Actual Finish Dates shall be printed for those activities in progress or completed.

3.5.4.1 Activity Report

A list of all activities sorted according to activity number or "I-NODE" AND "J-NODE" and then sorted according to Early Start Date. For completed activities the Actual Start Date shall be used as the secondary sort.

3.5.4.2 Logic Report

A list of Preceding and Succeeding activities for every activity in ascending order by activity number and then sorted according to Early Start Date. For completed activities the Actual Start Date shall be used as the secondary sort.

3.5.4.3 Total Float Report

A list of all activities sorted in ascending order of total float. Activities which have the same amount of total float shall be listed in ascending order of Early Start Dates.

3.5.4.4 Earnings Report

****

NOTE: Other reports are available and may be specified as needed. Care should be exercised so as not to require excessive reports which will not contribute to effective management.
****

A compilation of the Contractor's Total Earnings on the project from the Notice to Proceed until the most recent Monthly Progress Meeting. This report shall reflect the Earnings of specific activities based on the agreements made in the field and approved between the Contractor and Contracting Officer at the most recent Monthly Progress Meeting. Provided that the Contractor has provided a complete schedule update, this report shall serve as the basis of determining Contractor Payment. Activities shall be grouped by bid item and sorted by activity numbers. This report shall: sum all activities in a bid item and provide a bid item percent; and complete and sum all bid items to provide a total project percent complete. The printed report shall contain, for each activity: Activity Number or "i-node" and "j-node", Activity Description, Original Budgeted Amount, Total Quantity, Quantity to Date, Percent Complete (based on cost), Earnings to Date.

3.5.5 Network Diagram

The network diagram shall be required on the initial schedule submission and on monthly schedule update submissions. The network diagram shall depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished. The activity or event number, description, duration, and estimated earned value shall be shown on the diagram. The Contracting Officer will use, but is not limited to, the following conditions to review compliance with this paragraph:

3.5.5.1 Continuous Flow

Diagrams shall show a continuous flow from left to right with no arrows from right to left.

3.5.5.2 Project Milestone Dates

Dates shall be shown on the diagram for start of project, any contract required interim completion dates, and contract completion dates.

3.5.5.3 Critical Path

The critical path shall be clearly shown.

3.5.5.4 Banding

Activities shall be grouped to assist in the understanding of the activity sequence. Typically, this flow will group activities by category of work, work area and/or responsibility.

3.5.5.5 S-Curves

Earnings curves showing projected early and late earnings and earnings to date.

3.6 PERIODIC PROGRESS MEETINGS

Progress meetings to discuss payment shall include a monthly onsite meeting or other regular intervals mutually agreed to at the preconstruction conference. During this meeting the Contractor shall describe, on an activity by activity basis, all proposed revisions and adjustments to the project schedule required to reflect the current status of the project. The Contracting Officer will approve activity progress, proposed revisions, and adjustments as appropriate.

3.6.1 Meeting Attendance

The Contractor's Project Manager and Scheduler shall attend the regular progress meeting.

3.6.2 Update Submission Following Progress Meeting

A complete update of the project schedule containing all approved progress, revisions, and adjustments, based on the regular progress meeting, shall be submitted not later than 4 working days after the monthly progress meeting.

3.6.3 Progress Meeting Contents

Update information, including Actual Start Dates, Actual Finish Dates, Remaining Durations, and Cost-to-Date shall be subject to the approval of the Contracting Officer. The following is a minimum set of items which the Contractor shall address, on an activity by activity basis, during each progress meeting.

3.6.3.1 Start and Finish Dates

The Actual Start and Actual Finish dates for each activity currently in-progress or completed activities.

3.6.3.2 Time Completion

The estimated Remaining Duration for each activity in-progress. Time-based progress calculations must be based on Remaining Duration for each activity.

3.6.3.3 Cost Completion

The earnings for each activity started. Payment will be based on earnings for each in-progress or completed activity. Payment for individual activities will not be made for work that contains quality defects. A portion of the overall project amount may be retained based on delays of activities.

3.6.3.4 Logic Changes

All logic changes pertaining to Notice to Proceed on change orders, change orders to be incorporated into the schedule, contractor proposed changes in work sequence, corrections to schedule logic for out-of-sequence progress, lag durations, and other changes that have been made pursuant to contract provisions shall be specifically identified and discussed.

3.6.3.5 Other Changes

Other changes required due to delays in completion of any activity or group of activities include: 1) delays beyond the Contractor's control, such as strikes and unusual weather. 2) delays encountered due to submittals, Government Activities, deliveries or work stoppages which make re-planning the work necessary, and 3) a schedule which does not represent the actual prosecution and progress of the work.

3.7 REQUESTS FOR TIME EXTENSIONS

In the event the Contractor requests an extension of the contract completion date, he shall furnish such justification, project schedule data and supporting evidence as the Contracting Officer may deem necessary for a determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract. Submission of proof of delay, based on revised activity logic, duration, and costs (updated to the specific date that the delay occurred) is obligatory to any approvals.

3.7.1 Justification of Delay

The project schedule shall clearly display that the Contractor has used, in full, all the float time available for the work involved with this request. The Contracting Officer's determination as to the number of allowable days of contract extension shall be based upon the project schedule updates in effect for the time period in question, and other factual information. Actual delays that are found to be caused by the Contractor's own actions, which result in the extension of the schedule, will not be a cause for a time extension to the contract completion date.

3.7.2 Submission Requirements

The Contractor shall submit a justification for each request for a change in the contract completion date of under 2 weeks based upon the most recent schedule update at the time of the Notice to Proceed or constructive direction issued for the change. Such a request shall be in accordance with the requirements of other appropriate Contract Clauses and shall include, as a minimum:

a. A list of affected activities, with their associated project schedule activity number.

b. A brief explanation of the causes of the change.

c. An analysis of the overall impact of the changes proposed.

d. A sub-network of the affected area.

Activities impacted in each justification for change shall be identified by a unique activity code contained in the required data file.

3.7.3 Additional Submission Requirements

For any requested time extension of over 2 weeks, the Contracting Officer may request an interim update with revised activities for a specific change request. The Contractor shall provide this disk within 4 days of the Contracting Officer's request.

3.8 DIRECTED CHANGES

If Notice to Proceed (NTP) is issued for changes prior to settlement of price and/or time, the Contractor shall submit proposed schedule revisions to the Contracting Officer within 2 weeks of the NTP being issued. The proposed revisions to the schedule will be approved by the Contracting Officer prior to inclusion of those changes within the project schedule.

If the Contractor fails to submit the proposed revisions, the Contracting Officer may furnish the Contractor suggested revisions to the project schedule. The Contractor shall include these revisions in the project schedule until revisions are submitted, and final changes and impacts have been negotiated. If the Contractor has any objections to the revisions furnished by the Contracting Officer, the Contractor shall advise the Contracting Officer within 2 weeks of receipt of the revisions. Regardless of the objections, the Contractor shall continue to update the schedule with the Contracting Officer's revisions until a mutual agreement in the revisions is reached. If the Contractor fails to submit alternative revisions within 2 weeks of receipt of the Contracting Officer's proposed revisions, the Contractor will be deemed to have concurred with the Contracting Officer's proposed revisions. The proposed revisions will then be the basis for an equitable adjustment for performance of the work.

3.9 OWNERSHIP OF FLOAT

Float available in the schedule, at any time, shall not be considered for the exclusive use of either the Government or the Contractor.

-- End of Section --

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DEPARTMENT OF THE ARMY — **HED-01330 (March 1999)**

U.S. ARMY CORPS OF ENGINEERS — **--------------------------**

Superseding

CEGS-01300 (September 1997)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 01330

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03/99

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DEPARTMENT OF THE ARMY	**HED-01330 (March 1999)**
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	CEGS-01300 (September 1997)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 01330

SUBMITTAL PROCEDURES
03/99

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NOTE: This guide specification covers procedures to be used in making submittals called for in other sections of the specifications. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-700.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
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PART 1 GENERAL

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NOTE: SPECSINTACT includes 19 submittal descriptions. The ten submittal descriptions used in Corps of Engineers guide specifications (CEGS-Series) are included in this guide specification. The other nine submittal descriptions are used by the Naval Facilities Engineering Command (NAVFAC); therefore if NAVFAC guide specifications are used in a Corps project the following conversion should be made:

NAVFAC SD Number and Title	Convert To
SD-02 Manufacturer's Catalog Data	SD-01 Data
SD-03 Manufacturer's Standard Color Charts	SD-01 Data

NAVFAC SD Number and Title	Convert To
SD-05 Design Data	SD-01 Data
SD-10 Test Reports	SD-09 Reports
SD-11 Factory Test Report	SD-09 Reports
SD-12 Field Test Report	SD-09 Reports
SD-15 Color Selection Samples	SD-14 Samples
SD-16 Sample Panels	SD-14 Samples
SD-17 Sample Installation	SD-14 Samples

Definitions of submittals used in Corps of Engineers guide specifications (CEGS-Series) are as follows:

SD-01 Data

Submittals which provide calculations, descriptions, or documentation regarding the work.

SD-04 Drawings

Submittals which graphically show relationship of various components of the work, schematic diagrams of systems, details of fabrication, layouts of particular elements, connections, and other relational aspects of the work.

SD-06 Instructions

Preprinted material describing installation of a product, system or material, including special notices and material safety data sheets, if any, concerning impedances, hazards, and safety precautions.

SD-07 Schedules

Tabular lists showing location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work.

SD-08 Statements

A document, required of the Contractor, or through the Contractor, from a supplier, installer, manufacturer, or other lower tier Contractor, the purpose of which is to confirm the quality or orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel, qualifications, or other verifications of quality.

SD-09 Reports

Reports of inspections or tests, including analysis and interpretation of test results.

SD-13 Certificates

Statement signed by an official authorized to certify on behalf of the manufacturer of a product, system or material, attesting that the product, system or material meets specified requirements. The statement must be dated after the award of the contract, must state the Contractor's name and address, must name the project and location, and must list the specific requirements which are being certified.

SD-14 Samples

Samples, including both fabricated and unfabricated physical examples of materials, products, and units of work as complete units or as portions of units of work.

SD-18 Records

Documentation to record compliance with technical or administrative requirements.

SD-19 Operation and Maintenance Manuals

Data which forms a part of an operation and maintenance manual.

Submittal Description definitions are not included in Paragraph 1.1, SUBMITTAL IDENTIFICATION, since they are primarily for the guidance of project specification writers. A listing of SD numbers and titles is included in Paragraph 1.1 to accommodate the production of the SPECSINTACT submittal verification report.

The SD numbers and names, have been assigned by the SPECSINTACT Configuration, Control and Coordinating Board, and they correspond to the terminology used in the technical sections. These numbers and names should not be changed.
****

1.1   SUBMITTAL IDENTIFICATION

Submittals required are identified by SD numbers as follows:

SD-01 Data

SD-04 Drawings

SD-06 Instructions

SD-07 Schedules

SD-08 Statements

SD-09 Reports

SD-13 Certificates

SD-14 Samples

SD-18 Records

SD-19 Operation and Maintenance Manuals

1.2 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

1.2.1 Government Approved

Governmental approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer. Within the terms of the Contract Clause entitled "Specifications and Drawings for Construction," they are considered to be "shop drawings."

1.2.2 Information Only

All submittals not requiring Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

1.3 APPROVED SUBMITTALS

The Contracting Officer's approval of submittals shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the CQC requirements of this contract is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work. After submittals have been approved by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

1.4 DISAPPROVED SUBMITTALS

The Contractor shall make all corrections required by the Contracting Officer and promptly furnish a corrected submittal in the form and number of copies specified for the initial submittal. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, a notice in accordance with the Contract Clause "Changes" shall be given promptly to the Contracting Officer.

1.5 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL

The Contractor shall make submittals as required by the specifications. The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections. Units of weights and measures used on all submittals shall be the same as those used in the contract drawings. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved by the Contractor's Quality Control (CQC) representative and each item shall be stamped, signed, and dated by the CQC representative indicating action taken. Proposed deviations from the contract requirements shall be clearly identified. Submittals shall include items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals. Submittals requiring Government approval shall be scheduled and made prior to the acquisition of the material or equipment covered thereby. Samples remaining upon completion of the work shall be picked up and disposed of in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations.

3.2 SUBMITTAL REGISTER (ENG FORM 4288)

****

NOTE: The ENG Form 4288 (Submittal Register) is a tracking log for use in the field. This form is not a part of this guide specification; the completed ENG Form must be developed locally for each project.

SPECSINTACT has the capability to produce a Submittal List and a Submittal Register based on tagging elements surrounding submittal information within the sections.

SPECSINTACT steps used in producing the Submittal Register are provided below as background information in reference to submittal descriptions and items.

The Submittal Register is a report option which is available at the time of print. This option is used to generate and print the Submittal Register.

Before printing the Submittal Register, when creating a new section not covered by guide specifications, the following guidelines must be followed.

1. The Submittal Article must be in PART 1 and entitled "1.x SUBMITTALS" ("x" represents any number).

2. The Submittal Descriptions (SD-##, Title) are identified in the Submittal Article and are surrounded by "SUB, /SUB" and "LST, /LST" tags.

3. Submittal Items are listed below the submittal descriptions (SD-## Title), surrounded by "SUB, /SUB" and "TXT, /TXT" tags. If the submittal item is listed elsewhere, other than in the Submittal Article, it must appear as a paragraph and/or subparagraph title. By identifying these items within the text, it is not necessary to repeat the submittal description (SD-##) associated with it.

4. Submittal Classifications:

a. Government approved is required for submittals with a "GA" designation. All submittals not requiring Government approval will be for information only (FIO). The Submittal Classification must be included within Submittal tags.

b. Submittals having an A/E (or any three characters) are for the "Reviewer" and must be used in conjunction with "GA", Government Approved. The Reviewer's designation must appear immediately following the submittal item following the classification for government approved (GA). It must be separated from the classification (GA) by inserting a space, comma, pipe symbol or dash. The Classification and the Reviewer must both be included within the Submittal tags.

When the Submittal Register is generated, the system searches by section for the "Submittal Article" within Part 1. Next it will search for all tagged "Submittal Descriptions" (SD-##) listed under the Submittal Article and then the "Submittal Items" appearing below the SD numbers and throughout the section.

The system will automatically complete columns (d) through (r) which are, Specification Paragraph Number, Description of Item Submitted, Type of Submittal, Classification and Reviewer. The Submittal Register will then print a separate Submittal Register for each section. The system will insert the Title and Location in the upper left hand corner and the Specification Section Number in

the upper right hand corner of Submittal Register. The page numbering, at the bottom right hand corner, will be numbered consecutively, for each section. Tagged submittals in the Submittal Article must be consistent with those in the section text; however, this process is not sensitive to upper or lower case.

The remaining columns must be completed in manually by the Contractor. SPECSINTACT provides the Contractor the capability to create a submittal database diskette for the project (Submittal Register Program).

To create the diskette, select the Job Icon. In the FORMS/DOCUMENT menu:

Select Submittal Register Program.
Insert disk and press "ENTER."

To access Submittal Program (database) from disk, exit from SISGML and WINDOWS. From DOS prompt, change directory to the "A or B" drive and type "SUBMIT." For more information and help, press F1.

This database facilitates the transfer of submittal information from specifications to the Submittal database. The Contractor will then have the ability to electronically modify submittal information, in columns, (a),(b),(c),(s through z), and (aa) which are, Activity Number, Transmittal Number, Item Number, Contactor Schedule Dates, Contractor Action, Government Action and Remarks.

The submittal database is a stand-alone system for tracking and updating submittal information for the project. Updated submittal information in the database <u>cannot</u> be used in SPECSINTACT to alter submittal data in the specification.
****

ENG Form 4288 listing items of equipment and materials for which submittals are required by the specifications; this list may not be all inclusive and additional submittals may be required. The Contractor will also be given the submittal register as a diskette containing the computerized ENG Form 4288 and instructions on the use of the diskette. Columns "d" through "r" have been completed by the Government; the Contractor shall complete columns "a" and "s" through "u" and submit the forms (hard copy plus associated electronic file) to the Contracting Officer for approval within 30 calendar days after Notice to Proceed. The Contractor shall keep this diskette up-to-date and shall submit it to the Government together with the monthly payment request. The approved submittal register will become the scheduling document and will be used to control submittals throughout the life of the contract. The submittal register and the progress schedules shall be coordinated.

3.3 SCHEDULING

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. Adequate time (a minimum of 30 calendar days exclusive of mailing time) shall be allowed and shown on the register for review and approval. No delay damages or time extensions will be allowed for time lost in late submittals. An additional 15 calendar days shall be allowed and shown on the register for review and approval of submittals for food service equipment and refrigeration and HVAC control systems.

3.4 TRANSMITTAL FORM (ENG FORM 4025)

****

NOTE: ENG Form 4025 is not a part of this guide specification; the sample ENG Form 4025 must be added to this section locally.

****

The sample transmittal form (ENG Form 4025) attached to this section shall be used for submitting both Government approved and information only submittals in accordance with the instructions on the reverse side of the form. These forms will be furnished to the Contractor. This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted. Special care shall be exercised to ensure proper listing of the specification paragraph and/or sheet number of the contract drawings pertinent to the data submitted for each item.

3.5 SUBMITTAL PROCEDURE

Submittals shall be made as follows:

3.5.1 Procedures

****

NOTE: Add applicable procedures, including where to be submitted and number of copies required.

****

Submittals to the Contracting Officer are required in the number of copies identified in paragraphs 3.7 and 3.8 and shall be submitted to:

[U.S. Army Corps of Engineer District, Honolulu
[Fort Shafter] [Schofield Barracks] Resident Office
Bldg 230
Fort Shafter, Hawaii 96858-5440

3.5.2 Deviations

For submittals which include proposed deviations requested by the Contractor, the column "variation" of ENG Form 4025 shall be checked. The Contractor shall set forth in writing the reason for any deviations and annotate such deviations on the submittal. The Government reserves the right to rescind inadvertent approval of submittals containing unnoted deviations.

3.6 CONTROL OF SUBMITTALS

The Contractor shall carefully control his procurement operations to ensure that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "Submittal Register."

3.7 GOVERNMENT APPROVED SUBMITTALS

Upon completion of review of submittals requiring Government approval, the submittals will be identified as having received approval by being so stamped and dated. 3 copies of the submittal will be retained by the Contracting Officer and 1 copy of the submittal will be returned to the Contractor.

3.8 INFORMATION ONLY SUBMITTALS

Submittals provided For Information Only (FIO) to the Government shall be submitted in three (3) copies, including resubmittals. Normally submittals for information only will not be returned. Approval of the Contracting Officer is not required on information only submittals. The Government reserves the right to require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or for check testing by the Government in those instances where the technical specifications so prescribe.

3.9 STAMPS

Stamps used by the Contractor on the submittal data to certify that the submittal meets contract requirements shall be similar to the following:

CONTRACTOR
(Firm Name)
_____ Approved
_____ Approved with corrections as noted on submittal data and/or attached sheets(s).
SIGNATURE: ____________________
TITLE: ____________________
DATE: ____________________

-- End of Section --

SECTION 01335 - SURVEY, LAYOUT, AND OTHER DATA

PART I - GENERAL (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 CONTRACTOR VERIFICATION OF CONTRACT SURVEY DATA

During initial site layout and before existing conditions are disturbed the Contractor shall verify, in writing, the basic survey data provided on the contract drawings. Verification shall be initiated from the point shown on the contract drawings or from the contract drawing reference point designated by the Contracting Officer's Authorized Representative and shall include, as a minimum, benchmark elevations, horizontal control points, and sufficient spot checks of critical elevations to ensure that the survey data adequately reflects existing conditions. The Contractor shall not proceed with construction until survey verification is provided to the Contracting Officer's Authorized Representative. Before an existing benchmark referenced on the contract drawings is disturbed, the Contractor shall establish a new benchmark which has been approved by the Contracting Officer's Authorized Representative. Benchmarks which are destroyed without authorization from the Contracting officer's Authorized Representative must be replaced at the Contractor's expense as prescribed in Section 00800 Special Clause, "Layout of Work." The Contractor shall refer to Contract Clauses, "Differing Site Conditions" and "Site Investigation and Conditions Affecting the Work," for additional requirements.

-- End of Section --

****

DEPARTMENT OF THE ARMY — **CEGS-01356 (August 1996)**
U.S. ARMY CORPS OF ENGINEERS — **------------------------**
CECW-EP — **Superceding**
CWGS-01565 (August 1996)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes Special Change to convert CWGS-01565 to one CEGS system and to renumber the specifications in accordance with the 1995 CSI MASTERFORMAT. (September 1998)
Includes Special Change to remove unused References from Reference Article (December 1998)
Includes Text Adjustment (December 1998)
Includes Changes Through Notice 1 (February 1999)
Latest Changes Indicated by CHG Tags

****

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08/96

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DEPARTMENT OF THE ARMY | **CEGS-01356 (August 1996)**
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SECTION 01356

STORM WATER POLLUTION PREVENTION MEASURES
08/96

****

NOTES: This guide specification covers the requirements for temporary construction measures most used in complying the Best Management Practices of the storm water pollution prevention plan as required by a NPDES Permit.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification must be tailored to meet the requirements of the job and must be tailored to meet the requirements of the permitting authority. Individual states may require prevention measures that differ from the ones specified in this section and, in that case, this guide specification must be tailored to meet those State requirements. This guide specification is required for all construction projects that include disturbing over 2 hectares (5 acres) of land surface area that could be a source for erosion and sediment pollution due to storm water runoff.

(1) A Notice of Intent (NOI) must be prepared and sent to the appropriate state licensing office or USEPA Regional Office. At this time, it has not been determined when to send in the NOI, but it must be done after preparation of a storm water pollution prevention plan, and perhaps after award of the contract because the names of the Contractors must be give on the NOI.

(2) After construction is completed, a Notice of Termination (NOT) must be sent to the state office or Regional USEPA Regional Office.

This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-2-1200 and ER 1110-1-8155.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4439	(1997) Standard Terminology for Geosynthetics
ASTM D 4491	(1996) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(1991; R 1996) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 1996)) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(1995) Determining Apparent Opening Size of a Geotextile
ASTM D 4873	(1995) Identification, Storage, and Handling of Geosynthetic Rolls

1.2 GENERAL

The Contractor shall implement the storm water pollution prevention measures specified in this section in a manner which will meet the requirements of Section 01354 ENVIRONMENTAL PROTECTION, and the requirements of the National Pollution Discharge Elimination System (NPDES) permit attached to that Section.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item on the project should be one of the primary factors in determining if a submittal for the items should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-13 Certificates

Mill Certificate or Affidavit; FIO.

1.4 EROSION AND SEDIMENT CONTROLS

The controls and measures required by the Contractor are described below.

1.4.1 Stabilization Practices

****

NOTE: Describe interim stabilization practices, including site-specific scheduling of the implementation of the practices. Plans should ensure that existing vegetation is preserved where attainable and disturbed areas are stabilized. Show locations for stabilization practices on the drawings.

****

The stabilization practices to be implemented shall include [temporary seeding,] [mulching,] [geotextiles,] [sod stabilization,] [vegetative buffer strips,] [erosion control matts,] [protection of trees,] [preservation of mature vegetation,] [etc]. On his daily CQC Report, the Contractor shall record the dates when the major grading activities occur, (e.g., [clearing] [and grubbing,] [excavation,] [embankment,] [and] [grading]); when construction activities temporarily or permanently cease on a portion of the site; and when stabilization practices are initiated. Except as provided in paragraphs UNSUITABLE CONDITIONS and NO ACTIVITY FOR LESS THAN 21 DAYS, stabilization practices shall be initiated as soon as practicable, but no more than 14 days, in any portion of the site where construction activities have [temporarily or] permanently ceased.

1.4.1.1 Unsuitable Conditions

Where the initiation of stabilization measures by the fourteenth day after construction activity [temporarily or] permanently ceases is precluded by unsuitable conditions caused by the weather, stabilization practices shall be initiated as soon as practicable after conditions become suitable.

1.4.1.2 No Activity for Less Than 21 Days

Where construction activity will resume on a portion of the site within 21 days from when activities ceased (e.g., the total time period that construction activity is temporarily ceased is less than 21 days), then stabilization practices do not have to be initiated on that portion of the site by the fourteenth day after construction activity temporarily ceased.

1.4.2 Structural Practices

****

NOTES: Describe structural practices to divert flows from exposed soils, store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site to the degree attainable. A permit under Section 404 of the Clean Water Act may be required for certain structural practices. Check with Permits Branch.

For common drainage locations that serve a disturbed area of 4 or more hectares (10 or more acres) at one time, a temporary or permanent detention basin providing 252 cubic meters of storage per hectare (3,600 cubic feet of storage per acre) drained, or equivalent control measures, shall be provided where attainable until stabilization of the site. The 252 cubic meters of storage per hectare (3,600 cubic feet of storage per acre) drained does not apply to flows from offsite areas and flows from onsite areas that are either undisturbed or have undergone final stabilization where such flows are diverted around the sediment basin. For drainage locations which serve a disturbed area of 4 or more hectares (10 or more acres) at one time and where a temporary sediment basin providing 252 cubic meters of storage per hectare (3,600 cubic feet of storage per acre) drained, or equivalent sediment controls, is not attainable, sediment controls are required for all sideslope and downslope boundaries of the construction area.

For drainage locations serving less than 4 hectares (10 acres), sediment traps, silt fences, or equivalent sediment controls are required for all sideslope and downslope boundaries of the construction area unless a sediment basin providing storage for 252 cubic meters of storage per hectare (3,600 cubic feet of storage per acre) drained is provided.

****

Structural practices shall be implemented to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Structural practices shall be implemented in a timely manner during the construction process to minimize erosion and sediment runoff. Structural practices shall include the following devices. [Location and details of installation and construction are shown on the drawings.]

****

NOTE: Listed are examples of typical structural devices. Requirements for Silt Fences, Straw Bales, and Diversion Dikes are contained within this Guide Specification. Specifications for other structural practices used in the project must be added to this section.

a. [Silt fences.]
b. [Straw bales.]
c. [Diversion dikes.]
d. [Drainage swales.]
e. [Check dams.]
f. [Subsurface drains.]
g. [Pipe Slope drains.]
h. [Level spreaders.]
i. [Storm drain inlet protection.]
j. [Rock outlet protection.]
k. [Sediment traps.]
l. [Reinforced soil retaining systems.]
m. [Gabions.]
n. [Sediment basins.]
o. [_____].

The permanent stabilization practices which are to be installed under the contract should be specified in other section of the specifications. These are measures that will be installed during the construction process to control pollutants in storm water discharges that will occur after construction operations have been completed. Structural measures should be placed on upland soils to the degree attainable. The installation of these devices may be subject to Section 404 of the Clean Water Act.

A goal of 80 percent removal of total suspended solids from these flows which exceed predevelopment levels should be used in designing and installing storm water management controls (where practicable). Where this goal is not met, the permittee shall provide justification for rejecting each practice listed above based on site conditions.

Velocity dissipation devices shall be placed at discharge locations and along the length of any

outfall channel as necessary to provide a non-erosive velocity flow from the structure to a water course so that the natural physical and biological characteristics and functions are maintained and protected.
****

1.4.2.1 [Silt Fences

The Contractor shall provide silt fences as a temporary structural practice to minimize erosion and sediment runoff. Silt fences shall be properly installed to effectively retain sediment immediately after completing each phase of work where erosion would occur in the form of sheet and rill erosion (e.g. clearing and grubbing, excavation, embankment, and grading). Silt fences shall be installed in the locations indicated on the drawings. Final removal of silt fence barriers shall be upon approval by the Contracting Officer.]

1.4.2.2 [Straw Bales

The Contractor shall provide bales of straw as a temporary structural practice to minimize erosion and sediment runoff. Bales shall be properly placed to effectively retain sediment immediately after completing each phase of work (e.g., clearing and grubbing, excavation, embankment, and grading) in each independent runoff area (e.g., after clearing and grubbing in a area between a ridge and drain, bales shall be placed as work progresses, bales shall be removed/replaced/relocated as needed for work to progress in the drainage area). Areas where straw bales are to be used are shown on the drawings. Final removal of straw bale barriers shall be upon approval by the Contracting Officer. Rows of bales of straw shall be provided as follows:

a. Along the downhill perimeter edge of all areas disturbed.

b. Along the top of the slope or top bank of drainage ditches, channels, swales, etc. that traverse disturbed areas.

c. Along the toe of all cut slopes and fill slopes of the construction areas.

****
NOTE: Space rows a maximum of 60 meters (200 feet) apart in drains with slopes equal to or less than 5 percent and 30 meters (100 feet) apart in drains with slopes steeper than 5 percent. If drainage ditches have slopes above and below the 5 percent limit the spacing should be shown on the drawings.
****

d. Perpendicular to the flow in the bottom of existing drainage ditches, channels, swales, etc. that traverse disturbed areas or carry runoff from disturbed areas. Rows shall be spaced [a maximum of [_____] feet apart] [as shown on the drawings].

e. Perpendicular to the flow in the bottom of new drainage ditches, channels, and swales. Rows shall be spaced [a maximum of [_____] feet apart] [as shown on the drawings].

f. At the entrance to culverts that receive runoff from disturbed areas.

g. [_____].]

1.4.2.3 [Diversion Dikes

Diversion dikes shall have a maximum channel slope of 2 percent and shall be adequately compacted to prevent failure. The minimum height measured from the top of the dike to the bottom of the channel shall be 18 inches. The minimum base width shall be 6 feet and the minimum top width shall be 2 feet. The Contractor shall ensure that the diversion dikes are not damaged by construction operations or traffic. Diversion dikes shall be located as shown on the drawings.]

PART 2 PRODUCTS

2.1 COMPONENTS FOR SILT FENCES

2.1.1 Filter Fabric

The geotextile shall comply with the requirements of ASTM D 4439, and shall consist of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. The filament shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of ester, propylene, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic to make the filaments resistance to deterioration due to ultraviolet and heat exposure. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 to 120 degrees F. The filter fabric shall meet the following requirements:

FILTER FABRIC FOR SILT SCREEN FENCE

PHYSICAL PROPERTY	TEST PROCEDURE	STRENGTH REQUIREMENT
Grab Tensile Elongation (%)	ASTM D 4632	100 lbs. min. 30 % max.
Trapezoid Tear	ASTM D 4533	55 lbs. min.
Permittivity	ASTM D 4491	0.2 sec-1
AOS (U.S. Std Sieve)	ASTM D 4751	20-100

2.1.2 Silt Fence Stakes and Posts

The Contractor may use either wooden stakes or steel posts for fence construction. Wooden stakes utilized for silt fence construction, shall have a minimum cross section of 2 inches by 2 inches when oak is used and 4 inches by 4 inches when pine is used, and shall have a minimum length of 5 feet. Steel posts (standard "U" or "T" section) utilized for silt fence construction, shall have a minimum weight of 1.33 pounds per linear foot and a minimum length of 5 feet.

2.1.3 Mill Certificate or Affidavit

A mill certificate or affidavit shall be provided attesting that the fabric and factory seams meet chemical, physical, and manufacturing requirements specified above. The mill certificate or affidavit shall specify the actual Minimum Average Roll Values and shall identify the fabric supplied by roll identification numbers. The Contractor shall submit a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the filter fabric.

2.1.4 Identification Storage and Handling

Filter fabric shall be identified, stored and handled in accordance with ASTM D 4873.

2.2 COMPONENTS FOR STRAW BALES

The straw in the bales shall be stalks from oats, wheat, rye, barley, rice, or from grasses such as byhalia, bermuda, etc., furnished in air dry condition. The bales shall have a standard cross section of 14 inches by 18 inches. All bales shall be either wire-bound or string-tied. The Contractor may use either wooden stakes or steel posts to secure the straw bales to the ground. Wooden stakes utilized for this purpose, shall have a minimum dimensions of 2 inches x 2 inches in cross section and shall have a minimum length of 3 feet. Steel posts (standard "U" or "T" section) utilized for securing straw bales, shall have a minimum weight of 1.33 pounds per linear foot and a minimum length of 3 feet.

PART 3 EXECUTION

3.1 INSTALLATION OF SILT FENCES

Silt fences shall extend a minimum of 16 inches above the ground surface and shall not exceed 34 inches above the ground surface. Filter fabric shall be from a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, filter fabric shall be spliced together at a support post, with a minimum 6 inch overlap, and securely sealed. A trench shall be excavated approximately 4 inches wide and 4 inches deep on the upslope side of the location of the silt fence. The 4-inch by 4-inch trench shall be backfilled and the soil compacted over the filter fabric. Silt fences shall be removed upon approval by the Contracting Officer.

3.2 INSTALLATION OF STRAW BALES

Straw bales shall be placed in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another. Straw bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings. The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. After the bales are staked and chinked (gaps filled by wedging with straw), the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to 4 inches against the uphill side of the barrier. Loose straw shall be scattered over the area immediately uphill from a straw bale barrier to increase barrier efficiency. Each bale shall be securely anchored by at least two stakes driven through the bale. The first stake or steel post in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or steel pickets shall be driven a minimum 18 inches deep into the ground to securely anchor the bales.

3.3 MAINTENANCE

****
NOTE: Describe the procedures to be follow during construction to maintain the vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition.
****

The Contractor shall maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition by performing routine inspections to determine condition and effectiveness, by restoration of destroyed vegetative cover, and by repair of erosion and sediment control measures and other protective measures. The following procedures shall be followed to maintain the protective measures.

3.3.1 Silt Fence Maintenance

Silt fences shall be inspected in accordance with paragraph INSPECTIONS. Any required repairs shall be made promptly. Close attention shall be paid to the repair of damaged silt fence resulting from end runs and undercutting. Should the fabric on a silt fence decompose or become ineffective, and the barrier is still necessary, the fabric shall be replaced promptly. Sediment deposits shall be removed when deposits reach one-third of the height of the barrier. When a silt fence is no longer required, it shall be removed. The immediate area occupied by the fence and any sediment deposits shall be shaped to an acceptable grade. The areas disturbed by this shaping shall [receive erosion control if required by Section [02___ EROSION CONTROL], paragraph [AREAS TO RECEIVE EROSION CONTROL] [be seeded in accordance with Section [02___] [ESTABLISHMENT OF TURF], [except that the coverage requirements in paragraph ESTABLISHMENT do not apply].

3.3.2 Straw Bale Maintenance

Straw bale barriers shall be inspected in accordance with paragraph INSPECTIONS. Close attention shall be paid to the repair of damaged bales, end runs and undercutting beneath bales. Necessary repairs to barriers or replacement of bales shall be accomplished promptly. Sediment deposits shall be removed when deposits reach one-half of the height of the barrier. Bale rows used to retain sediment shall be turned uphill at each end of each row. When a straw bale barrier is no longer required, it shall be removed. The immediate area occupied by the bales and any sediment deposits shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be seeded in accordance with Section [02___] TURF.

3.3.3 Diversion Dike Maintenance

Diversion dikes shall be inspected in accordance with paragraph INSPECTIONS. Close attention shall be paid to the repair of damaged diversion dikes and necessary repairs shall be accomplished promptly. When diversion dikes are no longer required, they shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be seeded in accordance with Section [02___] TURF.

3.4 INSPECTIONS

3.4.1   General

The Contractor shall inspect disturbed areas of the construction site, areas used for storage of materials that are exposed to precipitation that have not been finally stabilized, stabilization practices, structural practices, other controls, and area where vehicles exit the site at least once every seven (7) calendar days and within 24 hours of the end of any storm that produces 0.5 inches or more rainfall at the site. Where sites have been finally stabilized, such inspection shall be conducted at least once every month.

3.4.2   Inspections Details

Disturbed areas [and areas used for material storage that are exposed to precipitation] shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. Erosion and sediment control measures identified in the Storm Water Pollution Prevention Plan shall be observed to ensure that they are operating correctly. Discharge locations or points shall be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles exit the site shall be inspected for evidence of offsite sediment tracking.

3.4.3   Inspection Reports

For each inspection conducted, the Contractor shall prepare a report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the Storm Water Pollution Prevention Plan, maintenance performed, and actions taken. The report shall be furnished to the Contracting Officer within 24 hours of the inspection as a part of the Contractor's daily CQC REPORT. A copy of the inspection report shall be maintained on the job site.

3.4.4   [Monthly Inspection Report and Certification Form for Erosion and Sediment Controls

****

NOTE: Some States require submittal of inspection reports to their respective agency. If this is required in the state where the proposed project is located, the following example should be appropriately edited and included in the project specifications. The designer should attach the appropriate state forms at the end of this section.

****

On the first working day of each month the Contractor shall complete, sign, and submit the original form to the State of [____], [Office of Pollution Control (OPC)] at the following address:

Chief, [_____]
[_____]
[_____]
[_____]

A copy of the State of [_____]'s [Monthly Inspection Report and Certification Form for Erosion and Sediment Controls] is attached to the end of this section. On the first working day of each month the Contractor shall also furnish one copy of the form submitted to the [OPC] to the Contracting Officer as part of the Contractor's daily CQC Report and attach a copy of the completed form to the Plan. Unless otherwise notified by the [OPC], the Contractor shall submit the [Monthly Inspection Report and Certification Forms] for an additional two months after the final completion of all storm water pollution prevention measures required in this contract have been implemented.]

-- End of Section --

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS

HED-01430 (February 1998)

Superseding
HED-01430 (October 1997)

GUIDE SPECIFICATION FOR MILITARY CONSTRUCTION

****

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U.S. ARMY CORPS OF ENGINEERS | **----------------------**
Superseding
HED-01430 (October 1997)

GUIDE SPECIFICATION FOR MILITARY CONSTRUCTION

****

SECTION 01430

ENVIRONMENTAL PROTECTION
02/98

****

NOTE: This guide specification covers the requirements for environmental protection. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-720.

****

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

STATE OF HAWAII DEPARTMENT OF HEALTH (HIDOH)

HIDOH, Chapter 43	Administrative Rules, Title 11, Community Noise Control for Oahu
HIDOH, Chapter 59	Administrative Rules, Ambient Air Quality Standards
HIDOH, Chapter 60	Administrative Rules, Air Pollution Control

1.2 GENERAL REQUIREMENTS

This section covers prevention of environmental pollution and damage as the result of construction operations under this contract and for those measures set forth in the TECHNICAL REQUIREMENTS. For the purpose of this specification, environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of air, water, and land, and includes management of visual aesthetics, noise, solid waste, radiant energy and radioactive materials, as well as other pollutants.

1.2.1 Subcontractors

Assurance of compliance with this section by subcontractors will be the responsibility of the Contractor.

1.2.2 Notification

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with the aforementioned Federal[,] [State] or local laws or regulations, permits, and other elements of the Contractor's environmental protection plan. The Contractor shall, after receipt of such notice, inform the Contracting Officer of proposed corrective action and take such action as may be approved. If the Contractor fails to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions will be granted or costs or damages allowed to the Contractor for any such suspension.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the projects should be one of the primary factors in determining if a submittal for the item should required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-18 Records

Environmental Protection Plan; GA.

Within 30 calendar days of receipt of Notice to Proceed, the Contractor shall submit in writing an environmental protection plan. Approval of the Contractor's plan will not relieve the Contractor of his responsibility for adequate and continuing control of pollutants and other environmental protection measures. The environmental protection plan shall include but not be limited to the following:

a. A list of Federal[,] [State,] and local laws, regulations, and permits concerning environmental protection, pollution control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits.

****

NOTE: This paragraph will be edited based on editing of text herein.

****

b. Methods for protection of features to be preserved within authorized work areas. The Contractor shall prepare a listing of methods to protect resources needing protection; i.e., trees, shrubs, vines, grasses and ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, archeological, and cultural resources.

c. Procedures to be implemented to provide the required environmental protection and to comply with the applicable laws and regulations. The Contractor shall set out the procedures to be followed to correct pollution of the environment due to accident, natural causes, or failure to follow the procedures set out in accordance with the environmental protection plan.

d. Location of the solid waste disposal area.

e. Drawings showing locations of any proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials.

f. Environmental monitoring plans for the job site, including land, water, air, and noise monitoring.

g. Traffic control plan.

h. Methods of protecting surface and ground water during construction activities.

i. Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas.

j. Plan of borrow area(s).

k. Training for his personnel during the construction period.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 PROTECTION OF ENVIRONMENTAL RESOURCES

The environmental resources within the project boundaries and those affected outside the limits of permanent work under this contract shall be protected during the entire period of this contract. The Contractor shall confine his activities to areas defined by the drawings and specifications.

3.1.1 Land Resources

Prior to the beginning of any construction, the Contractor shall identify all land resources to be preserved within the Contractor's work area. Except in areas indicated on the drawings or specified to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without special permission from the Contracting Officer. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. Where such special emergency use is permitted, the Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs.

3.1.1.1 Work Area Limits

Prior to any construction, the Contractor shall mark the areas that are not required to accomplish all work to be performed under this contract. Isolated areas within the general work area which are to be saved and protected shall also be marked or fenced. Monuments and markers shall be protected before construction operations commence. Where construction operations are to be conducted during darkness, the markers shall be visible. The Contractor shall convey to his personnel the purpose of marking and/or protection of all necessary objects.

3.1.1.2 Protection of Landscape

Trees, shrubs, vines, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved shall be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques.

3.1.1.3 Reduction of Exposure of Unprotected Erodible Soils

Earthwork brought to final grade shall be finished as indicated and specified. Side slopes and back slopes shall be protected as soon as practicable upon completion of rough grading. All earthwork shall be planned and conducted to minimize the duration of exposure of unprotected soils. Except in instances where the constructed feature obscures borrow areas, quarries, and waste material areas, these areas shall not initially be cleared in total. Clearing of such areas shall progress in reasonably sized increments as needed to use the areas developed as approved by the Contracting Officer.

3.1.1.4 Protection of Disturbed Areas

Such methods as necessary shall be utilized to effectively prevent erosion and control sedimentation, including but not limited to the following:

a. Retardation and Control of Runoff: Runoff from the construction site shall be controlled by construction of diversion ditches, benches, and berms to retard and divert runoff to protected drainage courses, and any measures required by areawide plans approved under Paragraph 208 of the Clean Water Act.

b. Erosion and Sedimentation Control Devices: The Contractor shall construct or install all temporary and permanent erosion and sedimentation control features as indicated on the drawings. Temporary erosion and sediment control measures such as berms, dikes, drains, [sedimentation basins,] grassing, and mulching shall be maintained until permanent drainage and erosion control facilities are completed and operative.

[c. Sediment Basins: Sediment from construction areas shall be trapped in temporary or permanent sediment basins in accordance with basin plans shown on the drawings. The basins shall accommodate the runoff of a local [design year] storm. After each storm, the basins shall be pumped dry and accumulated sediment shall be removed as necessary to maintain basin effectiveness. Overflow shall be controlled by paved weir or by vertical overflow pipe, draining from the surface. The collected topsoil sediment shall be reused for fill on the construction site, and/or conserved (stockpiled) for use at another site(s). The Contractor shall institute effluent quality monitoring programs as required by [State and] local environmental agencies.]

3.1.1.5 Contractor Facilities and Work Areas

a. Location of Field Offices, Storage, and Other Contractor Facilities: The Contractors' field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas designated on the drawings or as directed by the Contracting Officer. Temporary movement or relocation of Contractor facilities shall be made only on approval by the Contracting Officer.

b. Borrow Areas on Government Property: Borrow areas shall be managed to minimize erosion and to prevent sediment from entering nearby waters.

c. Spoil Areas on Government Property: Spoil areas shall be managed and controlled to limit spoil to areas designated on the drawings and prevent erosion of soil or sediment from entering nearby waters. Spoil areas shall be developed in accordance with the grading plan indicated on the drawings.

d. Temporary Excavations and Embankments: Temporary excavations and embankments for plant and/or work areas shall be controlled to protect adjacent areas from despoilment.

3.1.2 Disposal of Wastes

Disposal of wastes shall be as specified in [Section 01900 MISCELLANEOUS PROVISIONS] [Section 02050 DEMOLITION] and as specified hereinafter.

3.1.2.1 Solid Wastes

Solid wastes (excluding clearing debris) shall be placed in containers which are emptied on a regular schedule. All handling and disposal shall be conducted to prevent contamination. Segregation measures shall be employed such that no hazardous or toxic waste will become commingled with solid waste. [The Contractor shall transport all solid waste off Government property and dispose of it in compliance with Federal, State, and local requirements for solid waste disposal.] [Waste materials shall be hauled to the Government landfill site [shown on the drawings.] [designated by the Contracting Officer.] The Contractor shall comply with [site procedures and with] Federal[,] [State,] and local laws and regulations pertaining to the use of landfill areas.]

3.1.2.2 Chemical Wastes:

****

NOTE: For Kwajalein projects, the first bracketed paragraph will be deleted and the second bracketed paragraph will be retained.

For all other projects the first bracketed paragraph will be retained.

****

[Chemical wastes shall be stored in corrosion resistant containers, removed from the work area and disposed of in accordance with Federal[,] [State,] and local laws and regulations.]

[Chemicals shall be dispensed in a way to adequately ensure no spillage to ground or water. Periodic inspections of dispensing areas to identify leakage and initiate corrective action shall be performed and documented. This documentation will be periodically reviewed by the Government. Chemical waste shall be collected in corrosion resistant containers with care taken to ensure compatibility. Collection drums shall be monitored and removed to a staging or storage area when contents are within six inches of the top. All waste shall be disposed of in accordance with Federal and local laws and regulations.]

3.1.2.3 Hazardous Wastes:

The Contractor shall take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing and shall collect waste in suitable containers observing compatibility. The Contractor shall transport all hazardous waste off Government property and dispose of it in compliance with Federal and local laws and regulations. Spills of hazardous or toxic materials shall be immediately reported to the Contracting Officer. Cleanup and cleanup costs due to spills shall be the responsibility of the Contractor.

3.1.3 Historical, Archeological, and Cultural Resources

[Existing historical, archeological, and cultural resources within the Contractor's work area will be so designated by the Contracting Officer if any has been identified. The Contractor shall take precautions to preserve all such resources as they existed at the time they were pointed out to him. The Contractor shall provide and install all protection for these resources so designated and shall be responsible for their preservation during this contract.] If during excavation or other construction activities [in areas with existing or known resources, as well as in any other work area], any [previously] unidentified or unanticipated resources are discovered or found, all activities that may damage or alter such resources shall be temporarily suspended. These resources or cultural remains (prehistoric or historic surface or subsurface) include but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rocks or coral alignments, paving, wall, or other constructed features; and any indication of agricultural or other uses. Upon such discovery or find, the Contractor shall immediately notify the Contracting Officer. When so notified, the Contracting Officer will initiate action so that prompt and proper data recovery can be accomplished. In the mean time, recording and preservation of historical and archeological finds during construction activities shall be reported in accordance with the SPECIAL CONTRACT REQUIREMENTS.

3.1.4 Water Resources

****

NOTE: For Kwajalein projects, the last bracketed sentence will be retained.

****

The Contractor shall keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters. Special management techniques as set out below shall be implemented to control water pollution by the listed construction activities which are included in this contract. [In particular, toxic or hazardous chemicals shall not be applied to soil or vegetation in a manner that may cause contamination of the fresh water reserve.]

3.1.4.1 Washing and Curing Water

****
NOTE: For Kwajalein projects, the last bracketed sentence will be retained.
****

Waste waters directly derived from [Insert Name(s) of Process Producing the Wastewater] construction activities shall not be allowed to enter water areas. These waste waters shall be collected and placed in retention ponds where suspended material can be settled out or the water evaporates so that pollutants are separated from the water. [Analysis shall be performed and results reviewed and approved by the Government before water in retention ponds is discharged.]

3.1.4.2 Cofferdam and Diversion Operations

The Contractor shall plan his operation and perform all work necessary to minimize adverse impact of violation of the water quality standard for [Insert Name of Water Area(s)]. Construction operations for dewatering, removal of cofferdams, tailrace excavation, and tunnel closure shall be controlled at all times to limit the impact of water turbidity on the habitat for wildlife and impacts on water quality for downstream use.

3.1.4.3 Stream Crossings

Stream crossings shall be controlled during construction. Crossings shall provide movement of materials or equipment which do not violate water pollution control standards of the Federal[,] [State] or local government.

3.1.4.4 Monitoring of Water Areas:

Monitoring of water areas affected by construction activities shall be the responsibility of the Contractor. All water areas affected by construction activities shall be monitored by the Contractor.

3.1.5 Fish and Wildlife Resources

The Contractor shall keep construction activities under surveillance, management and control to minimize interference with, disturbance to and damage of fish and wildlife. Species that require specific attention along with measures for their protection will be listed by the Contractor prior to beginning of construction operations.

3.1.6 Air Resources

The Contractor shall keep construction activities under surveillance, management and control to minimize pollution of air resources. All activities, equipment, processes, and work operated or performed by the Contractor in accomplishing the specified construction shall be in strict accordance with [HIDOH, Chapter 59, HIDOH, Chapter 60, and] all Federal emission and performance laws and standards. Ambient Air Quality Standards set by the Environmental Protection Agency shall be maintained for those construction operations and activities specified in this section. Special management techniques as set out below shall be implemented to control air pollution by the construction activities which are included in the contract.

3.1.6.1 Particulates

a. Dust particles, aerosols, and gaseous by-products from all construction activities, processing and preparation of materials, such as from asphaltic batch plants, shall be controlled at all times, including weekends, holidays and hours when work is not in progress.

b. The Contractor shall maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause the air pollution standards mentioned in paragraph Air Resources, herein before, to be exceeded or which would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated at such intervals as to keep the disturbed area damp at all times. The Contractor must have sufficient competent equipment available to accomplish this task. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs.

3.1.6.2 Hydrocarbons and Carbon Monoxide

Hydrocarbons and carbon monoxide emissions from equipment shall be controlled to Federal [and State] allowable limits at all times.

3.1.6.3 Odors

Odors shall be controlled at all times for all construction activities, processing and preparation of materials.

3.1.6.4 Monitoring of Air Quality

****

NOTE: For Kwajalein projects, the last bracketed sentence will be retained.

****

Monitoring of air quality shall be the responsibility of the Contractor. All air areas affected by the construction activities shall be monitored by the Contractor. [Monitoring results will be periodically reviewed by the Government to ensure compliance.]

3.1.7 Sound Intrusions

The Contractor shall keep construction activities under surveillance, and control to minimize damage to the environment by noise. [The Contractor shall comply with the provisions of HIDOH, Chapter 43.]

3.2 POST CONSTRUCTION CLEANUP

The Contractor shall clean up area(s) used for construction.

3.3 RESTORATION OF LANDSCAPE DAMAGE

The Contractor shall restore all landscape features damaged or destroyed during construction operations outside the limits of the approved work areas. Such restoration shall be in accordance with the plan submitted for approval by the Contracting Officer. This work will be accomplished at the Contractor's expense.

3.4 MAINTENANCE OF POLLUTION CONTROL FACILITIES

The Contractor shall maintain all constructed facilities and portable pollution control devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

3.5 TRAINING OF CONTRACTOR PERSONNEL IN POLLUTION CONTROL

The Contractor shall train his personnel in all phases of environmental protection. The training shall include methods of detecting and avoiding pollution, familiarization with pollution standards, both statutory and contractual, and installation and care of facilities (vegetative covers, and instruments required for monitoring purposes) to ensure adequate and continuous environmental pollution control.

-- End of Section --

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DEPARTMENT OF THE ARMY **HED-01451 (January 2000)**
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01/00

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****

SECTION 01451

CONTRACTOR QUALITY CONTROL
01/00

****
NOTE: This guide specification covers requirements for Contractor Quality Control. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-700.

Comments and suggestions on thisguide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3740	(1996) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM E 329	(1995b) Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

1.2 PAYMENT

Separate payment will not be made for providing and maintaining an effective Quality Control program, and all costs associated therewith shall be included in the applicable unit prices or lump-sum prices contained in the Bidding Schedule.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL

The Contractor is responsible for quality control and shall establish and maintain an effective quality control system in compliance with the Contract Clause titled "Inspection of Construction." The quality control system shall consist of plans, procedures, and organization necessary to produce an end product which complies with the contract requirements. The system shall cover all construction operations, both onsite and offsite, and shall be keyed to the proposed construction sequence. The project superintendent will be held responsible for the quality of work on the job and is subject to removal by the Contracting Officer for non-compliance with quality requirements specified in the contract. The project superintendent in this context shall mean the individual with the responsibility for the overall management of the project including quality and production.

3.2 QUALITY CONTROL PLAN

3.2.1 General

The Contractor shall furnish for review by the Government, not later than 30 days after receipt of notice to proceed, the Contractor Quality Control (CQC) Plan proposed to implement the requirements of the Contract Clause titled "Inspection of Construction." The plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used. The Government will consider an interim plan for the first 90 days of operation. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of work to be started. Work outside of the features of work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of work to be started.

3.2.2 Content of the CQC Plan

The CQC Plan shall include, as a minimum, the following to cover all construction operations, both onsite and offsite, including work by subcontractors, fabricators, suppliers, and purchasing agents:

a. A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff shall implement the three phase control system for all aspects of the work specified. The staff shall include a CQC System Manager who shall report to the project superintendent.

b. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function. Technicians responsible for sampling and testing of concrete shall be certified by the American Concrete Institute (ACI) or the Concrete Technicians Association of Hawaii (CTAH). Proof of certification shall be included in the CQC Plan. Personnel qualifications may be furnished incrementally as the work progresses, but in no case, less than fourteen (14) calendar days before personnel are required on the job.

c. A copy of the letter to the CQC System Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop work which is not in compliance with the contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Copies of these letters shall also be furnished to the Government.

d. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with Section 01330 SUBMITTAL PROCEDURES.

e. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test.

f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.

g. Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures shall establish verification that identified deficiencies have been corrected.

h. Reporting procedures, including proposed reporting formats.

i. A list of the definable features of work. A definable feature of work is a task which is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable features under a particular section. This list will be agreed upon during the coordination meeting.

3.2.3 Acceptance of Plan

Acceptance of the Contractor's plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Government reserves the right to require the Contractor to make changes in his CQC Plan and operations including removal of personnel, as necessary, to obtain the quality specified.

3.2.4 Notification of Changes

After acceptance of the CQC Plan, the Contractor shall notify the Contracting Officer in writing of any proposed change. Proposed changes are subject to acceptance by the Contracting Officer.

3.3 COORDINATION MEETING

After the Preconstruction Conference, before start of construction, and prior to acceptance by the Government of the CQC Plan, the Contractor shall meet with the Contracting Officer or Authorized Representative and discuss the Contractor's quality control system. The CQC Plan shall be submitted for review a minimum of 7 calendar days prior to the Coordination Meeting. During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting shall be prepared by the Government and signed by both the Contractor and the Contracting Officer. The minutes shall become a part of the contract file. There may be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures which may require corrective action by the Contractor.

3.4 QUALITY CONTROL ORGANIZATION

3.4.1 General

The requirements for the CQC organization are a CQC System Manager and sufficient number of additional qualified personnel to ensure contract compliance. The Contractor shall provide a CQC organization which shall be at the site at all times during progress of the work and with complete authority to take any action necessary to ensure compliance with the contract. All CQC staff members shall be subject to acceptance by the Contracting Officer.

3.4.2 CQC System Manager

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NOTE: The designer should insert desired requirements, evaluate the project to determine the level of CQC System Manager required, and select options accordingly.

****

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NOTE: The CEGS directs that the designer insert

desired requirements based on project knowledge. Except for major construction projects (hospitals, hotels, etc.) requiring project specific preparation for necessarily stricter CQC System Manager's requirement, one of the two following two paragraphs shall be selected by the designer, which will be reviewed by field office during BCOE review for validation or changing of option selection as preferred.

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****

NOTE: Larger projects greater than $1 millon, choose 1st bracket. Smaller projects less than $1 million, choose 2nd bracket.

****

[The Contractor shall identify as CQC System Manager an individual within the onsite work organization who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the Contractor. The CQC System Manager shall be a construction person with a minimum of 5 years in related work. This CQC System manager shall be on the site at all time during construction and shall be employed by the prime Contractor. The CQC System Manger shall be assigned no other duties. An alternate for the CQC System Manager shall be identified in the plan to serve in the event of the System Manager's absence. The requirements for the alternate shall be the same as the designated CQC System Manager.]

[The Contractor shall identify as CQC System Manager an individual within the onsite work organization who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the Contractor. The CQC System Manager shall be a construction person with a minimum of 5 years in related work. This CQC System Manager shall be on the site at all times during construction and shall be employed by the prime Contractor. The CQC System Manager shall be assigned as System Manager, but may have duties as project superintendent in addition to quality control. An alternate for the CQC System Manager shall be identified in the plan to serve in the event of the System Manager's absence. The requirement for the alternate shall be the same as for the designated CQC Systems Manager.]

3.4.3 CQC Personnel

****

NOTE: Insert desired requirements if the complexity, or size of the project warrants specialized individuals in specific disciplines to perform quality control. Select options accordingly.

****

In addition to CQC personnel specified elsewhere in the contract, the Contractor shall provide as part of the CQC organization specialized personnel to assist the CQC System Manager. If it is subsequently determined by the Contracting Officer that the minimum contract CQC requirements are not being met, the Contractor may be required to provide additional staff personnel to the CQC organization at no cost to the Government.

3.4.4 Additional Requirement

The CQC System Manager shall have completed the course entitled "Construction Quality Management For Contractors". This course is periodically offered at the General Contractors Association of Hawaii.

3.4.5 Organizational Changes

The Contractor shall maintain the CQC staff at full strength at all times. When it is necessary to make changes to the CQC staff, the Contractor shall revise the CQC Plan to reflect the changes and submit the changes to the Contracting Officer for acceptance.

3.5 SUBMITTALS

Submittals shall be made as specified in Section 01330 SUBMITTAL PROCEDURES. The CQC organization shall be responsible for certifying that all submittals are in compliance with the contract requirements.

3.6 CONTROL

Contractor Quality Control is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. At least three phases of control shall be conducted by the CQC System Manager for each definable feature of work as follows:

3.6.1 Preparatory Phase

This phase shall be performed prior to beginning work on each definable feature of work, after all required plans/documents/materials are approved/accepted, and after copies are at the work site. This phase shall include:

a. A review of each paragraph of applicable specifications.

b. A review of the contract drawings.

c. A check to assure that all materials and/or equipment have been tested, submitted, and approved.

d. Review of provisions that have been made to provide required control inspection and testing.

e. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the contract.

f. A physical examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.

g. A review of the appropriate activity hazard analysis to assure safety requirements are met.

h. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of work.

i. A check to ensure that the portion of the plan for the work to be performed has been accepted by the Contracting Officer.

j. Discussion of the initial control phase.

****

NOTE: Notification for preparatory phase shall be as follows:

Oahu - 48 hours
Kwajalein - 72 hours
Outer Island - 7 days
Pacific Areas - Construction to provide during BCOE process review

****

k. The Government shall be notified at least [_____] [hours] [days] in advance of beginning the preparatory control phase. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The results of the preparatory phase actions shall be documented by separate minutes prepared by the CQC System Manager and attached to the daily CQC report. The Contractor shall instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

3.6.2 Initial Phase

This phase shall be accomplished at the beginning of a definable feature of work. The following shall be accomplished:

a. A check of work to ensure that it is in full compliance with contract requirements. Review minutes of the preparatory meeting.

b. Verify adequacy of controls to ensure full contract compliance. Verify required control inspection and testing.

c. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with required sample panels as appropriate.

d. Resolve all differences.

e. Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.

****

NOTE: Notificaton for initial phase shall be as follows:

Oahu - 24 hours
Kwajalein - 72 - hours
OuterIsland - 7 days

****

f. The Government shall be notified at least [_____] [hours] [days] in advance of beginning the initial phase. Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the daily CQC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.

g. The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.

3.6.3 Follow-up Phase

Daily checks shall be performed to assure control activities, including control testing, are providing continued compliance with contract requirements, until completion of the particular feature of work. The checks shall be made a matter of record in the CQC documentation. Final follow-up checks shall be conducted and all deficiencies corrected prior to the start of additional features of work which may be affected by the deficient work. The Contractor shall not build upon nor conceal non-conforming work.

3.6.4 Additional Preparatory and Initial Phases

Additional preparatory and initial phases shall be conducted on the same definable features of work if the quality of on-going work is unacceptable, if there are changes in the applicable CQC staff, onsite production supervision or work crew, if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.7 TESTS

3.7.1 Testing Procedure

The Contractor shall perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements. Upon request, the Contractor shall furnish to the Government duplicate samples of test specimens for possible testing by the Government. Testing includes operation and/or acceptance tests when specified. The Contractor shall obtain the services of an industry recognized testing laboratory, or may establish a testing laboratory at the project site acceptable to the Contracting Officer. However, tests contractually required to be performed by an industry recognized testing laboratory shall not be accomplished by the Contractor established on-site laboratory. The Contractor shall perform the following activities and record and provide the following data:

a. Verify that testing procedures comply with contract requirements.

b. Verify that facilities and testing equipment are available and comply with testing standards.

c. Check test instrument calibration data against certified standards.

d. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.

e. Results of all tests taken, both passing and failing tests, shall be recorded on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test shall be given. If approved by the Contracting Officer, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an offsite or commercial test facility shall be provided directly to the Contracting Officer. Failure to submit timely test reports as stated may result in nonpayment for related work performed and disapproval of the test facility for this contract.

3.7.2 Testing Laboratories

3.7.2.1 Laboratory Accreditation

The testing laboratory performing the actual testing on the project shall be accredited by one of the following laboratory accreditation authorities:

American Association of State Highway and Transportation Officials
National Voluntary Laboratory Accreditation Program
American Association for Laboratory Accreditation
Washington Association of Building Officials

The testing laboratory shall submit an acknowledgement letter from one of the listed laboratory accreditation authorities indicating that the application for accreditation has been received and the accreditation process started.

3.7.2.2 Capability Check

The Government reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt, and steel shall meet criteria detailed in ASTM D 3740 and ASTM E 329.

3.7.2.3 Capability Recheck

If the selected laboratory fails the capability check, the Contractor shall reimburse reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the contract amount due the Contractor.

3.7.3 Onsite Laboratory

The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

3.7.4 Furnishing or Transportation of Samples for Testing

****
NOTE: Insert appropriate addresses.
****

Costs incidental to the transportation of samples or materials shall be borne by the Contractor. Samples of materials for test verification and acceptance testing by the Government shall be delivered to a testing laboratory on the Island of Oahu, State of Hawaii, designated by the Contracting Officer. Coordination for each specific test, exact delivery location, and dates will be made through the Government field office.

3.8 COMPLETION INSPECTION

3.8.1 Punch-Out Inspection

Near the completion of all work or any increment thereof established by a completion time stated in the Special Clause entitled "Commencement, Prosecution, and Completion of Work," or stated elsewhere in the specifications, the CQC System Manager shall conduct an inspection of the work and develop a punch list of items which do not conform to the approved drawings and specifications. Such a list of deficiencies shall be included in the CQC documentation, as required by paragraph DOCUMENTATION below, and shall include the estimated date by which the deficiencies will be corrected. The CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected. Once this is accomplished, the Contractor shall notify the Government that the facility is ready for the Government Pre-Final inspection.

3.8.2 Pre-Final Inspection

The Government will perform this inspection to verify that the facility is complete and ready to be occupied. The QC Manager shall develop a punch list of items which do not conform to the contract documents. The Government will review the punch list and add to or correct the items listed. The QC Manager shall incorporate Government comments and provide a Pre-Final Punch List. The Contractor's CQC System Manager shall ensure that all items on this list have been corrected before notifying the Government so that a Final inspection with the customer can be scheduled. Any items noted on the Pre-Final inspection shall be corrected in a timely manner. These inspections and any deficiency corrections required by this paragraph shall be accomplished within the time slated for completion of the entire work or any particular increment thereof if the project is divided into increments by separate completion dates.

3.8.3 Final Acceptance Inspection

The Contractor's Quality Control Inspection personnel, plus the superintendent or other primary management person, and the Contracting Officer's Representative shall be in attendance at this inspection. Additional Government personnel including, but not limited to, those from Base/Post Civil Facility Engineer user groups, and major commands may also be in attendance. The final acceptance inspection will be formally scheduled by the Contracting Officer based upon results of the Pre-Final inspection. Notice shall be given to the Contracting Officer at least 14 days prior to the final acceptance inspection and shall include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final acceptance inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with the contract clause titled "Inspection of Construction".

3.9 DOCUMENTATION

The Contractor shall maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the work of subcontractors and suppliers and shall be on an acceptable form that includes, as a minimum, the following information:

a. Contractor/subcontractor and their area of responsibility.

b. Operating plant/equipment with hours worked, idle, or down for repair.

c. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.

d. Test and/or control activities performed with results and references to specifications/drawings requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.

e. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications/drawings requirements.

f. Submittals reviewed, with contract reference, by whom, and action taken.

g. Off-site surveillance activities, including actions taken.

h. Job safety evaluations stating what was checked, results, and instructions or corrective actions.

i. Instructions given/received and conflicts in plans and/or specifications.

j. Contractor's verification statement.

These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. The original and one copy of these records in report form shall be furnished to the Government daily within 24 hours after the date covered by the report, except that reports need not be submitted for days on which no work is performed. As a minimum, one report shall be prepared and submitted for every 7 days of no work and on the last day of a no work period. All calendar days shall be accounted for throughout the life of the contract. The first report following a day of no work shall be for that day only. Reports shall be signed and dated by the CQC System Manager. The report from the CQC System Manager shall include copies of test reports and copies of reports prepared by all subordinate quality control personnel.

3.10 NOTIFICATION OF NONCOMPLIANCE

The Contracting Officer will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-01500 (February 1997)**

U.S. ARMY CORPS OF ENGINEERS **---------------------------**

Superseding

CEGS-01500 (September 1993)

GUIDE SPECIFICATION FOR CONSTRUCTION

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02/97

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DEPARTMENT OF THE ARMY **CEGS-01500 (February 1997)**
U.S. ARMY CORPS OF ENGINEERS **---------------------------**
Superseding
CEGS-01500 (September 1993)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 01500

TEMPORARY CONSTRUCTION FACILITIES
02/97

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NOTE: This guide specification covers the requirements for temporary construction facilities. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

1.1 GENERAL REQUIREMENTS

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NOTE: This guide specification includes requirements which may be included in projects when applicable. Requirements will be added, deleted, or modified as necessary to meet project requirements.
****

1.1.1 Site Plan

The Contractor shall prepare a site plan indicating the proposed location and dimensions of any area to be fenced and used by the Contractor, the number of trailers to be used, avenues of ingress/egress to the fenced area and details of the fence installation. Any areas which may have to be graveled to prevent the tracking of mud shall also be identified. The Contractor shall also indicate if the use of a supplemental or other staging area is desired.

1.1.2 Identification of Employees

The Contractor shall be responsible for furnishing to each employee, and for requiring each employee engaged on the work to display, identification as approved and directed by the Contracting Officer. Prescribed identification shall immediately be delivered to the Contracting Officer for cancellation upon release of any employee. When required, the Contractor shall obtain and provide fingerprints of persons employed on the project. Contractor and subcontractor personnel shall wear identifying markings on hard hats clearly identifying the company for whom the employee works.

1.1.3 Employee Parking

Contractor employees shall park privately owned vehicles in an area designated by the Contracting Officer. This area will be within reasonable walking distance of the construction site. Contractor employee parking shall not interfere with existing and established parking requirements of the military installation.

1.2 AVAILABILITY AND USE OF UTILITY SERVICES

1.2.1 Payment for Utility Services

The Government will make all reasonably required utilities available to the Contractor from existing outlets and supplies, as specified in the contract. Unless otherwise provided in the contract, the amount of each utility service consumed shall be charged to or paid for by the Contractor at prevailing rates charged to the Government or, where the utility is produced by the Government, at reasonable rates determined by the Contracting Officer. The Contractor shall carefully conserve any utilities furnished without charge.

1.2.2 Meters and Temporary Connections

The Contractor, at its expense and in a manner satisfactory to the Contracting Officer, shall provide and maintain necessary temporary connections, distribution lines, and meter bases (Government will provide meters) required to measure the amount of each utility used for the purpose of determining charges. The Contractor shall notify the Contracting Officer, in writing, 5 working days before final electrical connection is desired so that a utilities contract can be established. The Government will provide a meter and make the final hot connection after inspection and approval of the Contractor's temporary wiring installation. The Contractor shall not make the final electrical connection.

1.2.3 Advance Deposit

An advance deposit for utilities consisting of an estimated month's usage or a minimum of $50.00 will be required. The last monthly bills for the fiscal year will normally be offset by the deposit and adjustments will be billed or returned as appropriate. Services to be rendered for the next fiscal year, beginning 1 October, will require a new deposit. Notification of the due date for this deposit will be mailed to the Contractor prior to the end of the current fiscal year.

1.2.4 Final Meter Reading

Before completion of the work and final acceptance of the work by the Government, the Contractor shall notify the Contracting Officer, in writing, 5 working days before termination is desired. The Government will take a final meter reading, disconnect service, and remove the meters. The Contractor shall then remove all the temporary distribution lines, meter bases, and associated paraphernalia. The Contractor shall pay all outstanding utility bills before final acceptance of the work by the Government.

1.2.5 Sanitation

The Contractor shall provide and maintain within the construction area minimum field-type sanitary facilities approved by the Contracting Officer. Government toilet facilities will not be available to Contractor's personnel.

1.2.6 Telephone

The Contractor shall make arrangements and pay all costs for telephone facilities desired.

1.3 BULLETIN BOARD, PROJECT SIGN, AND PROJECT SAFETY SIGN

1.3.1 Bulletin Board

Immediately upon beginning of work, the Contractor shall provide a weatherproof glass-covered bulletin board not less than 36 by 48 inches in size for displaying the Equal Employment Opportunity poster, a copy of the wage decision contained in the contract, Wage Rate Information poster, and other information approved by the Contracting Officer. The bulletin board shall be located at the project site in a conspicuous place easily accessible to all employees, as approved by the Contracting Officer. Legible copies of the aforementioned data shall be displayed until work is completed. Upon completion of work the bulletin board shall be removed by and remain the property of the Contractor.

1.3.2 Project and Safety Signs

The requirements for the signs, their content, and location shall be as shown on the drawings. The signs shall be erected within 15 days after receipt of the notice to proceed. The data required by the safety sign shall be corrected daily, with light colored metallic or non-metallic numerals. Upon completion of the project, the signs shall be removed from the site.

1.4 PROTECTION AND MAINTENANCE OF TRAFFIC

During construction the Contractor shall provide access and temporary relocated roads as necessary to maintain traffic. The Contractor shall maintain and protect traffic on all affected roads during the construction period except as otherwise specifically directed by the Contracting Officer. Measures for the protection and diversion of traffic, including the provision of watchmen and flagmen, erection of barricades, placing of lights around and in front of equipment and the work, and the erection and maintenance of adequate warning, danger, and direction signs, shall be as required by the State and local authorities having jurisdiction. The traveling public shall be protected from damage to person and property. The Contractor's traffic on roads selected for hauling material to and from the site shall interfere as little as possible with public traffic. The Contractor shall investigate the adequacy of existing roads and the allowable load limit on these roads. The Contractor shall be responsible for the repair of any damage to roads caused by construction operations.

1.4.1 Haul Roads

The Contractor shall, at its own expense, construct access and haul roads necessary for proper prosecution of the work under this contract. Haul roads shall be constructed with suitable grades and widths; sharp curves, blind corners, and dangerous cross traffic shall be avoided. The Contractor shall provide necessary lighting, signs, barricades, and distinctive markings for the safe movement of traffic. The method of dust control, although optional, shall be adequate to ensure safe operation at all times. Location, grade, width, and alignment of construction and hauling roads shall be subject to approval by the Contracting Officer. Lighting shall be adequate to assure full and clear visibility for full width of haul road and work areas during any night work operations. Upon completion of the work, haul roads designated by the Contracting Officer shall be removed.

1.4.2 Barricades

The Contractor shall erect and maintain temporary barricades to limit public access to hazardous areas. Such barricades shall be required whenever safe public access to paved areas such as roads, parking areas or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic. Barricades shall be securely placed, clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night.

1.5 CONTRACTOR'S TEMPORARY FACILITIES

1.5.1 Administrative Field Offices

The Contractor shall provide and maintain administrative field office facilities within the construction area at the designated site. Government office and warehouse facilities will not be available to the Contractor's personnel.

1.5.2 Storage Area

The Contractor shall construct a temporary 6 foot high chain link fence around trailers and materials. The fence shall include plastic strip inserts, colored [green] [brown], so that visibility through the fence is obstructed. Fence posts may be driven, in lieu of concrete bases, where soil conditions permit. Trailers, materials, or equipment shall not be placed or stored outside the fenced area unless such trailers, materials, or equipment are assigned a separate and distinct storage area by the Contracting Officer away from the vicinity of the construction site but within the military boundaries. Trailers, equipment, or materials shall not be open to public view with the exception of those items which are in support of ongoing work on any given day. Materials shall not be stockpiled outside the fence in preparation for the next day's work. Mobile equipment, such as tractors, wheeled lifting equipment, cranes, trucks, and like equipment, shall be parked within the fenced area at the end of each work day.

1.5.3 Supplemental Storage Area

Upon Contractor's request, the Contracting Officer will designate another or supplemental area for the Contractor's use and storage of trailers, equipment, and materials. This area may not be in close proximity of the construction site but shall be within the military boundaries. Fencing of materials or equipment will not be required at this site; however, the Contractor shall be responsible for cleanliness and orderliness of the area used and for the security of any material or equipment stored in this area. Utilities will not be provided to this area by the Government.

1.5.4 Appearance of Trailers

Trailers utilized by the Contractor for administrative or material storage purposes shall present a clean and neat exterior appearance and shall be in a state of good repair. Trailers which, in the opinion of the Contracting Officer, require exterior painting or maintenance will not be allowed on the military property.

1.5.5 Maintenance of Storage Area

Fencing shall be kept in a state of good repair and proper alignment. Should the Contractor elect to traverse, with construction equipment or other vehicles, grassed or unpaved areas which are not established roadways, such areas shall be covered with a layer of gravel as necessary to prevent rutting and the tracking of mud onto paved or established roadways; gravel gradation shall be at the Contractor's discretion. Grass located within the boundaries of the construction site shall be mowed for the duration of the project. Grass and vegetation along fences, buildings, under trailers, and in areas not accessible to mowers shall be edged or trimmed neatly.

1.5.6 New Building

In the event a new building is constructed for the temporary project field office, it shall be a minimum 12 feet in width, 16 feet in length and have a minimum of 7 feet headroom. It shall be equipped with approved electrical wiring, at least one double convenience outlet and the required switches and fuses to provide 110-120 volt power. It shall be provided with a work table with stool, desk with chair, two additional chairs, and one legal size file cabinet that can be locked. The building shall be waterproof, shall be supplied with heater, shall have a minimum of two doors, electric lights, a telephone, a battery operated smoke detector alarm, a sufficient number of adjustable windows for adequate light and ventilation, and a supply of approved drinking water. Approved sanitary facilities shall be furnished. The windows and doors shall be screened and the doors provided with dead bolt type locking devices or a padlock and heavy duty hasp bolted to the door. Door hinge pins shall be non-removable. The windows shall be arranged to open and to be securely fastened from the inside. Glass panels in windows shall be protected by bars or heavy mesh screens to prevent easy access to the building through these panels. In warm weather, air conditioning capable of maintaining the office at 50 percent relative humidity and a room temperature 20 degrees F below the outside temperature when the outside temperature is 95 degrees F, shall be furnished. Any new building erected for a temporary field office shall be maintained by the Contractor during the life of the contract and upon completion and acceptance of the work shall become the property of the Contractor and shall be removed from the site. All charges for telephone service for the temporary field office shall be borne by the Contractor, including long distance charges up to a maximum of $75.00 per month.

1.5.7 Security Provisions

Adequate outside security lighting shall be provided at the Contractor's temporary facilities. The Contractor shall be responsible for the security of its own equipment; in addition, the Contractor shall notify the appropriate law enforcement agency requesting periodic security checks of the temporary project field office.

1.6 GOVERNMENT FIELD OFFICE

1.6.1 Resident Engineer's Office

The Contractor shall provide the Government Resident Engineer with an office, approximately 200 square feet in floor area, located where directed and providing space heat, electric light and power, and toilet facilities consisting of one lavatory and one water closet complete with connections to water and sewer mains. A mail slot in the door or a lockable mail box mounted on the surface of the door shall be provided. At completion of the project, the office shall remain the property of the Contractor and shall be removed from the site. Utilities shall be connected and disconnected in accordance with local codes and to the satisfaction of the Contracting Officer.

1.6.2 Trailer-Type Mobile Office

The Contractor may, at its option, furnish and maintain a trailer-type mobile office acceptable to the Contracting Officer and providing as a minimum the facilities specified above. The trailer shall be securely anchored to the ground at all four corners to guard against movement during high winds.

1.7 PLANT COMMUNICATION

Whenever the Contractor has the individual elements of its plant so located that operation by normal voice between these elements is not satisfactory, the Contractor shall install a satisfactory means of communication, such as telephone or other suitable devices. The devices shall be made available for use by Government personnel.

1.8 TEMPORARY PROJECT SAFETY FENCING

As soon as practicable, but not later than 15 days after the date established for commencement of work, the Contractor shall furnish and erect temporary project safety fencing at the work site. The safety fencing shall be a high visibility orange colored, high density polyethylene grid or approved equal, a minimum of 42 inches high, supported and tightly secured to steel posts located on maximum 10 foot centers, constructed at the approved location. The safety fencing shall be maintained by the Contractor during the life of the contract and, upon completion and acceptance of the work, shall become the property of the Contractor and shall be removed from the work site.

1.9 CLEANUP

Construction debris, waste materials, packaging material and the like shall be removed from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways shall be cleaned away. Materials resulting from demolition activities which are salvageable shall be stored within the fenced area described above or at the supplemental storage area. Stored material not in trailers, whether new or salvaged, shall be neatly stacked when stored.

1.10 RESTORATION OF STORAGE AREA

Upon completion of the project and after removal of trailers, materials, and equipment from within the fenced area, the fence shall be removed and will become the property of the Contractor. Areas used by the Contractor for the storage of equipment or material, or other use, shall be restored to the original or better condition. Gravel used to traverse grassed areas shall be removed and the area restored to its original condition, including top soil and seeding as necessary.

-- End of Section --

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DEPARTMENT OF THE ARMY **HED-01600 (Sept 1998)**
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09/98

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SECTION 01600

YEAR 2000 COMPLIANCE
09/98

PART 1 GENERAL

1.1 DEFINITIONS

Refer to definitions in statement entitled "YEAR 2000 COMPLIANCE - CONSTRUCTION CONTRACTS" in Section 00800, Special Contract Requirements, for the following terms:

"Information technology"
"Embedded Systems"
"Year 2000 Compliant"

****
NOTE: SECTION 00800 TO BE INSERTED BY POH CONTRACTING OFFICE.
****

1.2 GENERAL REQUIREMENTS

1.2.1 Year 2000 (Y2K) Compliance Requirements

Refer to statement entitled "YEAR 2000 COMPLIANCE - CONSTRUCTION CONTRACTS" in Section 00800, Special Contract Requirements, for Y2K compliance requirement.

****
NOTE: SECTION 00800 TO BE INSERTED BY POH CONTRACTING OFFICE.
****

1.2.2 Y2K Compliance Warranty.

Refer to clause entitled "WARRANTY OF CONSTRUCTION" in Section 00700, Contract Clauses, for warranty requirements.

****
NOTE: SECTION 00700 TO BE INSERTED BY POH CONTRACTING OFFICE.
****

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Inventory of Y2K Compliant Equipment; FIO

The Contractor shall provide an inventory of all information technology, including embedded systems (a.k.a. microprocessor-based equipment) furnished under this contract which may be affected by this Y2K compliance requirement. This inventory shall contain the following information:

--Contract number, project title, name of contractor
--Equipment name/label
--Indication on whether the information technology is currently Year 2000 compliant or requires an upgrade for compliance prior to government acceptance.
--Manufacturer's model/serial number and date manufactured
--Specific location of equipment, i.e., building/room number
--If equipment is a controller only, indicate what other equipment is controlled by this controller
--Interoperability: identify any other equipment that is sending/receiving information to monitor or control said equipment
--If a PC, including laptop, is required to program, update data, etc., of said equipment , provide PC specifications, operating software name and version number
--Method used to determine Y2K compliance, i.e., field test, manufacturer's Statement of Compliance, etc.

****

NOTE: NOTE: The following paragraphs covering Field Validation Test Procedures [SD-06], Field Validation Test Reports [SD-09], and Statement of Compliance [SD-18] will be included only in projects which contain high priority systems such as fire alarm and other life safety systems, electronic security, entry control systems, environment and health systems, emergency generators, uninterruptible power supplies (UPS), medical systems, elevators, generators and mission critical systems. In some case, HVAC systems and lighting controls may be considered high priority systems, depending on the type of facility

****

SD-06 Instructions

Y2K Field Validation Test Procedure; GA

The Contractor shall develop a Y2K field validation test procedure for each of the equipment/systems listed below and incorporate the minimum test requirements specified in PART 3. In those cases where individual components or equipment are interconnected as a system or subsystem, the entire system or subsystem will also be tested. If there is an interface where time and date data is transferred to any other equipment or system, whether the system is existing or contractor installed, the interface will be included in the system validation test. The Contractor shall contact the manufacturer of the information technology, including embedded systems, to obtain information on recommended testing procedures. If the manufacturer indicates that the information technology, including embedded systems, can not be tested due to possible damage to the equipment, loss of function, etc., the Contractor shall obtain Statement of Compliance from the manufacturer and submit it according to the SD-18 Records. All test procedures require government approval prior to testing and a government representative must witness all testing.

Fire detection and alarm systems
Electronic security systems
Utility monitoring and Control Systems
Medical equipment systems
Emergency generators
Elevator controllers

****

NOTE: . The above list of equipment shall be tailored to fit the project.

****

SD-09 Reports

Y2K Field Validation Test Reports; FIO

Test procedures and reports for Y2K Field Validation Testing. After receipt by the Contractor of written approval of the test procedures, the Contractor shall schedule the tests. Reports of the results of the field validation testing shall be delivered to the Government within 7 days after completion of each test.

SD-18 Records

Statement of Compliance, FIO

For each information technology, including information technology in embedded (a.k.a. microprocessor-based equipment), furnished under this project, that cannot be field tested for Y2K compliance, provide a Statement of Compliance from the manufacturer that information technology is Year 2000 compliant as defined in statement entitled "YEAR 2000 COMPLIANCE - CONSTRUCTION CONTRACTS." Statement of Compliance shall be signed by official authorized to sign on behalf of the manufacturer to attest for the Y2K compliance. The statement shall include the name and title of the individual signing the statement with the date of signature. The statement must be dated after issuance of the solicitation.

This statement shall also include the solicitation or contract number, project title, name of the Contractor, equipment name/label, manufacturer's label, manufacturer's model/serial number and date manufactured, and location of the equipment (i.e., building/room number.)

PART 2 PRODUCTS

2.1 EMBEDDED SYSTEMS

Refer to statement entitled "YEAR 2000 COMPLIANCE - CONSTRUCTION CONTRACTS" in Section 00800, Special Contract Requirements, for examples of information technology and embedded systems. Attachment, entitled "Examples of Embedded Systems" at the back of Section 00800, Special Contract Requirements, provides examples of embedded system.

PART 3 EXECUTION (NOT APPLICABLE)

****

NOTE: The following paragraphs will be included in the project specifications only if the project contains high priority systems. High priority systems include fire alarm and other life safety systems, electronic security, entry control systems, environment and health systems, emergency generators, uninterruptible power supplies (UPS), medical systems, elevators, generators and mission critical systems. In some case, HVAC systems and lighting controls may be considered critical systems, depending on the type of facility. If the following paragraphs are included in the project specifications, the words '(Not applicable)' shall be deleted from PART 3 EXECUTION.

****

3.1 TESTS

3.1.1 General Testing Requirements

The Contractor shall perform field validation testing and adjustment of the information technology, including embedded systems (a.k.a. microprocessor-based equipment), furnished under this contract which may be affected by this Y2K compliance requirement. The Contractor shall provide the personnel, equipment, instrumentation, and supplies necessary to perform the testing. Written notification of planned testing shall be given to the Government at least 30 days prior to the test; notice shall not be given until the Contractor has received written approval of the specific test procedures. Test procedures shall explain, in detail, step-by-step actions and expected results demonstrating compliance with the requirements of the specification. Test reports shall be used to document results of the tests.

3.1.2 Minimum Test Requirements

As a minimum, all equipment and systems will be tested to assure that they correctly calculate critical Y2K dates including, but not limited to:

(1) 1 January 2000
(2) 29 February 2000 - Required because 1900 was not a leap year
(3) 9 April 1999 - 99th day of the year, which may be 9999 in the Julian calendar, which may be interpreted as an error code.
(4) 9 September 1999 - In systems using day, month, year date format, date may be 9999, which may be interpreted as an error code.
(5) 10 January 2000 - The first date that requires 7 characters
(6) 10 October 2000 - The first date that requires 8 characters

Each equipment or system will be tested to assure that the above dates are calculated correctly when they are encountered while the equipment is powered up and functioning properly and that they will return to the correct date after the date is encountered and the equipment is powered down and restarted.

-- End of Section --

SECTION 01700 - CONTRACT CLOSEOUT

PART I - GENERAL

1.1 OPERATION AND MAINTENANCE MANUALS

For requirements on operation and maintenance manuals see Section: 00800 SPECIAL CONTRACT REQUIREMENTS.

1.2 VIDEOTAPING OF TRAINING FOR OPERATING AND SERVICE PERSONNEL

Each instruction or training period for operating and service personnel, shall be videotaped in VHS FORMAT by the Contractor. The taping shall include the entire session, and the original video tape(s) shall be labeled and turned over to the Contracting Officer. The video camera and tapes utilized by the Contractor, shall be of a quality to enable clear and understandable playbacks of the recorded events. The Contractor shall coordinate the content of each instruction period required in the Technical Provisions of these specifications with the Contracting Officer's representative prior to the actual start of the training period.

1.3 AS-BUILT DRAWINGS

For requirements on as-built drawings see Section 00800 SPECIAL CONTRACT REQUIREMENTS.

1.4 ADDITIONAL WARRANTY REQUIREMENTS

The warranty requirements specified in this paragraph are in addition to those specified in the Contract Clause WARRANTY OF CONSTRUCTION in Section 00700 CONTRACT CLAUSES.

1.4.1 Performance Bond

It is understood that the Contractor's Performance Bond will remain effective throughout the life of all warranties and warranty extensions. This paragraph is applicable to the Contractor's Warranty of Construction Only and does not apply to manufacturers' warranties on equipment, roofing, and other products.

(a) In the event the Contractor or his designated representative fails to commence and diligently pursue any work required under the Warranty of Construction Paragraph within a reasonable time after receipt of written notification pursuant to the requirements thereof, the Contracting Officer shall have a right to enforce the said work be performed under the Performance Bond by making written notice on the surety. If the surety fails or refuses to perform the obligation it assumed under the Performance Bond, the Contracting officer shall have the work performed by others, and after completion of the work, shall make demand for reimbursement of any or all expenses incurred by the Government while performing the work, including, but not limited to administrative expenses.

(b) Warranty repair work which threatens the health or safety of personnel, the physical safety of property or equipment, or which impairs operations, habitability of living spaces, etc., will be handled by the Contractor on an immediate basis as directed verbally by the Contracting Officer or his Authorized Representative. Written verification will follow verbal instructions. Failure of the Contractor to respond as verbally directed will be cause for the Contracting Officer or his authorized representative to have the warranty repair work performed by others and to proceed against the Contractor as outlined in the paragraph (a) above.

1.4.2 Pre-warranty Conference

Prior to contract completion and at a time designated by the Contracting Officer or his Authorized Representative, the Contractor shall meet with the Contracting Officer to develop a mutual understanding with respect to the requirements of Contract Clause WARRANTY OF CONSTRUCTION. Communication procedures for Contractor notification of warranty defects, priorities with respect to the type of defeat, reasonable time required for Contractor response, and other details deemed necessary by the Contracting Officer or his Authorized Representative for the execution of the construction warranty shall be established/reviewed at this conference.

In connection with these requirements and at the time of the Contractor's quality control completion inspection, the Contractor will furnish the name, telephone number and address of a licensed and bonded company which is authorized to initiate and pursue warranty work action on behalf of the Contractor. This single point of contact will be located within the local service area of the warrantied construction, will be continuously available, and will be responsive to Government inquiry on warranty work action and status. This requirement does not relieve the Contractor of any of his responsibilities in connection with contract clause or WARRANTY OF CONSTRUCTION.

1.4.3 Equipment Warranty Identification Tags

The Contractor shall provide warranty identification tags on all equipment installed under this contract. Tags and installation shall be in accordance with the requirements of Paragraph: EQUIPMENT IDENTIFICATION TAGS.

1.5 EQUIPMENT WARRANTY IDENTIFICATION TAGS

1.5.1 General Requirements

The Contractor shall provide warranty identification tags on all Contractor and Government furnished equipment which he has installed.

1.5.1.1 Tag Description and Installation

The tags shall be similar in format and size to the exhibits provided by this specification, they shall be suitable for interior and exterior locations, resistant to solvents, abrasion, and to fading caused by sunlight, precipitation, etc. These tags shall have a permanent pressure-sensitive adhesive back, and they shall be installed in a position that is easily (or most easily) noticeable. Contractor furnished equipment that has differing warranties on its components will have each component tagged.

1.5.1.2 Sample Tags

Sample tags shall be submitted to the Contracting Officer's Authorized Representative for his review and approval. These tags shall be filled out representative of how the Contractor will complete all other tags.

1.5.1.3 Tags for Warranted Equipment

The tag for this equipment shall be similar to the following. Exact format and size will be as approved by the Contracting Officer's Authorized Representative. The Contractor’s warranty expiration date and the final manufacturer's warranty expiration dates will be determined as specified by the Paragraph: WARRANTY OF CONSTRUCTION.

EQUIPMENT WARRANTY CONTRACTOR FURNISHED EQUIPMENT	
MFG	____________________ MODEL NO. ________
SERIAL NO.	____
CONTRACT NO.	____
CONTRACTOR NAME	____
CONTRACTOR WARRANTY EXPIRES	____
MFG WARRANTY (IES) EXPIRES	____

EQUIPMENT WARRANTY CONTRACTOR FURNISHED EQUIPMENT	
MFG	____________________ MODEL NO. ________
SERIAL NO.	____
CONTRACT NO.	____
DATE EQUIP PLACED IN SERVICE	____
MFG WARRANTY (IES) EXPIRES	____

1.5.1.4 Duplicate Information

If the manufacturer's name (MFG), model number and serial number are on the manufacturers equipment data plate and this data plate is easily found and fully legible, this information need not be duplicated on the equipment warranty tag.

1.5.2 Execution

The Contractor will complete the required information on each tag and install these tags on the equipment by the time of and as a condition of final acceptance of the equipment. The Contractor will schedule this activity in the Contractor progress reporting system. The final acceptance inspection is scheduled based upon notice from the Contractor, thus if the Contractor is at fault in this inspection being delayed, the Contractor shall, at his own expense, update the in-service and warranty expiration dates on these tags.

1.5.3 Payment

The work outlined above is a subsidiary portion of the contract work, and has a value to the Government approximating 5% of the value of the Contractor furnished equipment. The Contractor will assign up to that amount, as approved by the Contracting Officer's Authorized Representative.

l.5.4 Equipment Warranty Tag Replacement

Under the terms of this contract, the Contractor's warranty with respect to work repaired or replaced shall be for one year from the date of repair or replacement. Such activity shall include an updated warranty identification tag on the repaired or replaced equipment. The tag shall be furnished and installed by the Contractor, and shall be identical to the original tag, except that the Contractor's warranty expiration date will be one year from the date of acceptance of the repair or replacement.

1.6 INVENTORY OF CONTRACTOR FURNISHED AND INSTALLED EQUIPMENT

A list of equipment or units of equipment that: require electrical power or fuel, or may require removal or replacement such as AHUs, fans, air conditioners, compressors, condensers, boiler, thermal exchangers, pumps, cooling towers, tanks, fire hydrants, sinks, water closets, lavatories, urinals, shower stalls, and any other large plumbing fixtures, light fixtures, etc., shall be made and kept up to date as installed. The list shall be reviewed periodically by the Government to insure completeness and accuracy. Partial payment will be withheld for equipment not incorporated in the list. List shall include on each item as applicable: Description, Manufacturer, Model or Catalog No., Serial No., Input (power, voltage, BTU, etc.), Output (power, voltage, BTU, tons, etc.), Size or Capacity (tanks), and net inventory costs; any other data necessary to describe item and shall list all warrantors and warranty periods for each item of equipment. Final list shall be turned over to the Authorized Representative of the Contracting Officer at the time of the Contractor's quality control completion inspection.

1.7 INVENTORY OF GOVERNMENT FURNISHED CONTRACTOR INSTALLED EQUIPMENT (GF/CI)

A list of all GF/CI equipment shall be developed for each Task Order and updated as necessary to reflect contract changes. Equipment items will be as defined under inventory of Contractor furnished equipment above and the list shall include, on each item, as applicable, the same information. The final list shall be turned over to the Contracting Officer's Representative, at the time of the Contractor's quality control inspection.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

-- End of Section --

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DEPARTMENT OF THE ARMY **HED-01900 (September 1999)**
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PART 3 EXECUTION (NOT APPLICABLE)

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SECTION 01900

MISCELLANEOUS PROVISIONS
09/99

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NOTE: This guide specification covers the requirements for miscellaneous provisions. This guide specification is to be used in the preparation of project specifications in accordance with ER 110-345-720.

****

PART 1 GENERAL

This section is provided for general guidance only. Special provisions for each individual task order will be provided as required. This section shall be included and modified, if required, for work plans prepared under each task order in this contract.

1.1 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having a "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment Data; FIO.

****

NOTE: Include this submittal for all Kwajalein projects. Delete this submittal for all other projects unless otherwise directed by the POD Technical Manager.

****

A list of all equipment furnished under this contract. This list shall include, but not be limited to, each piece of equipment with a serial number, and shall include all information shown on the manufacturer's nameplate, so as to positively identify the piece of equipment. This list shall also include the cost of each piece of equipment (less installation costs) F.O.B. construction site. This list shall be furnished as soon as possible after equipment is purchased. The list shall consist of one (1) reproducible and three (3) copies, and shall be furnished to the Contracting Officer not later than thirty (30) calendar days prior to completion of any segment of the contract work which has an incremental completion date.

SD-04 Drawings

As-Built Drawings; FIO.

SD-07 Schedules

Progress Chart; GA. Bar Chart; GA.

****

NOTE: SD-07 Schedules and SD-09 Reports were developed for and will be retained for family housing projects.

****

The Contractor shall prepare and submit for approval by the Contracting Officer a progress chart in accordance with the CONTRACT CLAUSE entitled "SCHEDULE FOR CONSTRUCTION CONTRACTS" twenty-one (21) calendar days prior to initiation of any work. Any material change to the progress chart must be approved in writing in advance by the Contracting Officer. [In addition to and along with the progress chart for the overall project, the Contractor shall submit for approval by the Contracting Officer a bar chart [for each type of [building[[dwelling unit] to be renovated under this contract,] showing the sequence and duration of the various elements of Construction to be performed [on that type of [building] [dwelling unit]]. Any proposed changes to the approved schedule shall be requested by the Contractor in writing a minimum of fourteen (14) calendar days prior to the proposed start of work.

SD-09 Reports

Inspection of Existing Conditions; FIO.

A written report with color photographs noting the condition of the existing facilities at the time of the inspection. One copy of the report including photographs shall be submitted to the [[Barbers Point] [Fort Shafter] [Hickam] [Kaneohe] [Pearl Harbor] [Schofield] Area Family Housing Office] [Contracting Officer], prior to construction.

SD-18 Records

Dust Control; GA.

Method(s) of dust control.

Excavation/Trenching Clearance; FIO.

Prior to start of any excavation or trenching work, the Contractor shall obtain clearance, in writing, from the appropriate communications agency and base or area engineer. Copies of all correspondence shall be provided the Contracting Officer. Normal coordination time for obtaining the necessary permits is approximately fifteen (15) calendar days. The Contractor shall advise the Contracting Officer promptly when it appears that the normal coordination time will be exceeded.

Condition of Contractor's Operation or Storage Area; FIO.

The Contractor shall submit to the Contracting Officer photographs and/or videos depicting the condition of the Contractor's Operation or Storage Area.

1.2   CONTRACTOR QUALITY CONTROL

To assure compliance with contract requirements, the Contractor shall establish and maintain quality control for materials and work covered by all sections of the TECHNICAL REQUIREMENTS in accordance with Section 01451 CONTRACTOR QUALITY CONTROL. Records shall be maintained for all operations including sampling and testing.

1.3   AS-BUILT DRAWINGS

As-built drawings shall be in accordance with SPECIAL CONTRACT REQUIREMENT entitled "AS-BUILT DRAWINGS".

1.4   DUST CONTROL

****

NOTE: If Section 02220 Demolition is made part of these project specifications, retain the first bracketed sentence and delete the second bracketed sentences.

****

[Dust control shall be in accordance with Section 02220 DEMOLITION.] [The amount of dust resulting from the Contractor's work shall be controlled to prevent the spread of dust to occupied portions of the construction site and to avoid creation of a nuisance in the surrounding area. Use of water will not be permitted when it will result in, or create, hazardous or objectionable conditions such as flooding and pollution.] Measures shall also be taken for dust control along haul routes and equipment parking areas.

1.5   PROTECTION

The Contractor shall take all necessary precautions to insure that no damages to private or public property will result from his operations. Any such damages shall be repaired or property replaced by the Contractor in accordance with the CONTRACT CLAUSES entitled "PERMITS AND RESPONSIBILITIES" and "PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS", without delay, and at no cost to the Government.

1.5.1   Warning Signs and Barricades

The Contractor shall be responsible for posting warning signs or erecting temporary barricades to provide for safe conduct of work and protection of property.

1.5.2 Protection of Grassed and Landscaped Areas

The Contractor's vehicles shall be restricted to paved roadways and driveways. Vehicles shall not be driven or parked on grassed and/or landscaped areas except when absolutely necessary for the performance of the work and approved in advance by the Contracting Officer. Grassed or landscaped areas damaged by the Contractor shall be restored to their original condition without delay and at no cost to the Government.

1.5.3 Protection of Trees and Plants

Where necessary, tree branches and plants interfering with the work may be temporarily tied back by the Contractor to permit accomplishment of the work in a convenient manner, so long as they will not be permanently damaged thereby. If this is not feasible, they may be pruned, subject to written approval by the Contracting Officer.

1.5.4 Protection of Building From the Weather

The interior of the building and all materials and equipment shall be protected from the weather at all times.

1.6 RESTORATION WORK

Existing conditions or areas damaged or disturbed by the Contractor's operations shall be restored to their original condition, or near original condition as possible, to the satisfaction of the Contracting Officer.

1.7 REMOVAL AND DISPOSAL

****

NOTE 1: If Section 02220 Demolition is made part of these project specifications, retain the first bracketed sentence and delete subparagraphs 1.7.1 and 1.7.2.

NOTE 2: If there are items to be salvaged, include Section 02050 Demolition in project specifications.

****

[Removal and disposal shall be in accordance with Section 02220 DEMOLITION.] The Contractor shall salvage or recycle waste to the maximum extent practical as it relates to the capabilities of local industries. A record of the quantity of salvaged or recycled materials shall be maintained by the Contractor during the length of the project and submitted to the Contracting Officer at acceptance of the project. Quantities shall be recorded in the unit of measure of the industry. Reuse of materials on the site shall be considered a form of recycling. An example of such reuse would be the use of acceptable excavated materials as fill.

1.7.1 Title to Materials

Title to all materials and equipment to be removed, except as indicated or specified otherwise, is vested in the Contractor upon receipt of notice to proceed. The Government will not be responsible for the condition, loss or damage to such property after the Contractor's receipt of notice to proceed. Items indicated to be removed shall be removed and disposed of by the Contractor [as indicated] [as designated] [outside the limits of Government-controlled property] at the Contractor's responsibility and expense before the completion and final acceptance of the work [for each [building] [dwelling unit]], and such materials shall not be sold on the site.

1.7.2 Rubbish and Debris

Rubbish and debris shall be removed from Government-controlled property daily unless otherwise directed, so as not to allow accumulation [inside or outside the building]. Materials that cannot be removed daily shall be stored in areas designated by the Contracting Officer.

1.8 INTERFERENCE WITH GOVERNMENT OPERATIONS

The Contractor shall establish work procedures and methods to prevent interference with existing operations within or adjacent to the construction area. Free passage into adjoining or adjacent buildings not in the contract will not be permitted except as approved by the Contracting Officer. Procedures and methods shall also provide for safe conduct of work and protection of property which is to remain undisturbed.

1.8.1 Coordination

The Contractor shall coordinate all work with the Contracting Officer to minimize interruption and inconvenience to the occupants or to the Government. Scheduling and programming of work will be established during the pre-construction conference.

1.8.2 Materials and Equipment

****

NOTE: This paragraph was developed for and will be retained for family housing projects. Specifically projects in which interruption to occupants of buildings being repaired and disturbance of the neighborhood must be minimized.

This paragraph may be used on other projects as required, but normally is deleted.

****

All materials and equipment required to complete the project shall be on hand before work is started.]

1.8.3 Utilities and Facilities

All utilities and facilities within the [area] [building] [dwelling units] shall remain operable and shall not be affected by the Contractor's work, unless otherwise approved in writing in advance by the Contracting Officer.

1.8.4 Staking and Flagging Existing Utilities

****

NOTE: Unless utility work is extensive, or if existing utility lines are sensitive, delete

requirements for locating existing utility lines by walking trench alinements with pipe and cable locating equipment.
****
The Contractor, prior to start of any excavation or trenching work, shall verify the location of all utility lines shown on the drawings which are within the areas of work, and shall mark, stake, or flag each utility line along trench alignments and under areas of excavation under this project, as approved. [Existing utility lines shall be located by walking trench alignments with approved equipment for locating underground pipes and cables.] Utility lines so located shall be noted on the drawings.

1.8.5 Smoking

****
NOTE: This paragraph will be retained for all projects at Tripler Army Medical Center.
****

Tripler Army Medical Center has been designated a NO SMOKING area. At no time will smoking be allowed within the hospital, including all construction areas within the hospital. Smoking will be allowed only on the exterior ground level of the hospital 50 feet from the building.

1.9 CONTRACTOR'S OPERATIONS OR STORAGE AREA

****
NOTE: Coordinate the Contractor's Operations or Storage Area with the Technical Manager at POD. The Contractor's Operations or Storage Area should be shown on the drawings, including dimensions, and this paragraph edited accordingly.
****

At the request of the Contractor, an open operations or storage area [of approximately _________ square feet] will be made available within the installation, [as shown on the drawings] [the exact location of which will be determined by the Government]. The Contractor shall be responsible for the security necessary for protection of his equipment and materials, and shall maintain the area free of debris. No rusty or unsightly materials shall be used for providing the secure measure and such measure shall be erected in a workmanlike manner. Before any construction commences on establishing the operation/storage area, Contractor shall take photographs and/or videos of the site in order to establish the original conditions of the site. A duplicate set shall be made and submitted to the Government for its files. Upon completion and prior to the final acceptance of the contract work, the Contractor shall restore the area to its original condition.

1.10 GOVERNMENT PROJECT OFFICE

****
NOTE: Obtain requirements for Government project office from the Technical Manager at POD. If required, retain paragraph and modify as necessary.
****
The Contractor shall provide, for use by Government supervisory and

inspection personnel, a job-site office space with a floor area not less than 150 square feet. This office space may be within the Contractor's project office building if adjacent to the job site and if separated by a solid partition; otherwise a separate facility, adjacent to the job site, shall be provided with windows and screens, electricity, including a minimum of four (4) wall outlets and two (2) ceiling lights, a telephone, a desk with drawers, a layout table, two (2) chairs, a legal size five-drawer locking file cabinet, and a fire extinguisher. Potable drinking water and temporary toilet facilities shall be made available to Government personnel, not necessarily within the project office, but in close proximity thereof. The cost of utilities including telephone, and operation and maintenance costs of the Government project office shall be borne by the Contractor. The Government will be responsible for its long-distance calls. Upon completion of the project, the project office and furnishings shall be removed and disposed of by the Contractor.

1.11 INSPECTION

1.11.1 Final Inspection and Acceptance

The Contractor shall give the [Barbers Point] [Fort Shafter] [Hickam] [Kaneohe] [Pearl Harbor] [Schofield] Area Family Housing Office, through the Contracting Officer, a minimum of fourteen (14) calendar days advance notice prior to final inspection [of each [building] [dwelling unit]] for acceptance by the Contracting Officer. All deficiencies found on final inspection [of each [building] [dwelling unit]] shall be promptly and satisfactorily corrected by the Contractor upon notification by the Contracting Officer.

1.12 WORKING DIRECTIVES

****

NOTE: Paragraphs 1.12.1 through 1.12.8 were developed for and will be retained/edited for family housing projects only for the following conditions: a. Interior work in occupied units. b. Interior work in unoccupied units. c. Exterior work on units that may be occupied or unoccupied. d. Exterior site work.

****

1.12.1 Working Hours

All work shall be performed between the hours of 0730 to 1600 HST, Monday through Friday. No work shall be accomplished on Saturdays, Sundays, and all federal holidays without written permission from the Contracting Officer. Such written permission shall be available at the job site at all times during construction.

1.12.2 Occupancy

[Building] [Dwelling units] to be renovated under this contract [will] [may] be [occupied] [unoccupied] during the time of construction. At times, and as directed by the Contracting Officer, the Contractor will be required to deviate from the approved schedule to accomplish work in the [buildings] [dwelling units] that have been recently vacated, and to work out of sequence for the occupants' convenience. If a [building] [set of dwelling units] becomes unavailable on the scheduled availability date due to exigency, the Government reserves the right to cancel the item of work, to substitute another [building] [set of dwelling units], or to reschedule the particular [building] [set of dwelling units] at a later date.

1.12.3 Availability of Work Areas

a. [The Contractor shall limit his work to __ [building(s)] [dwelling unit(s) at any given time.] [After approval of the Contractor's schedule and within [ninety (90)] [___] calendar days after receipt of notice to proceed, the [building(s)] [dwelling unit(s)] will be made available to the Contractor in the following order:

b. Initially a minimum of [______ buildings] [one increment of dwelling units consisting of at least _______________ and not more than _____________ dwelling units] will be made available to the Contractor, but in no case prior to the Contracting Officer's approval of the Contractor's progress chart and such time as the Contracting Officer is assured that no undue work stoppage is likely to be caused by the lack of materials, equipment, or personnel.

c. [___ additional buildings] [An additional increment of dwelling units (consisting of at least ____________ and not more than dwelling units)] will be made available to the Contractor upon satisfactory completion and acceptance of the initial [buildings] [increment of dwelling units] and its acceptance by the Contracting Officer. Thereafter, upon satisfactory completion and acceptance of the [building(s)] [dwelling unit(s)], an equivalent number of [building(s)] [dwelling unit(s)] will be made available to the Contractor.]

d. All required construction at a particular [building] [dwelling unit] shall be completed within [five (5)] [____] consecutive work days after that [building] [dwelling unit] is made available to the Contractor. Once the work has started, the Contractor shall continue performance through each workday until completion, except for lunch periods and other normal breaks. The Contractor shall ensure that all required materials and equipment are on hand, including adequate work force before starting work. Work stoppage will not be permitted without the approval of the Contracting Officer.

1.12.4 Obtaining Keys to Unoccupied Dwelling Units

The Contractor shall be responsible for obtaining keys from the [Barbers Point] [Fort Shafter] [Hickam] [Kaneohe] [Pearl Harbor] [Schofield] Area Family Housing Office to all unoccupied (vacant) dwelling units requiring work and shall return said keys immediately upon completion of work. The Contractor shall be responsible for the cost of replacing any keys that are lost. If the Contracting Officer determines that the locks must be replaced because of this loss, the Contractor shall also pay for this replacement.

1.12.5 Notification of Occupants

a. The initial notification of the occupants, including their responsibilities, will be accomplished by the [Barbers Point] [Fort Shafter] [Hickam] [Kaneohe] [Pearl Harbor] [Schofield] Area Family Housing Office.

b. After the Schedule has been approved, the affected occupants shall be notified by the Contractor of the date and time work will begin in that [building] [dwelling unit] and to remove or safeguard their valuables and personal effects.

c. The Contractor shall by letter notify each dwelling unit a minimum of seven (7) calendar days prior to commencement of work on that [building] [dwelling unit]. This notification shall include the time, the date, and any pertinent changes to the progress chart or any special requirements approved by the Contracting Officer. If the scheduled work is delayed for any cause, the affected occupants shall be notified immediately in writing by the Contractor, and they shall be notified again in writing by the Contractor prior to the commencement of rescheduled work. The Contractor shall include the following information in all delay and rescheduling notices:

(l) Title of Contract
(2) Originally Scheduled Date of Work
(3) Cause of Delay
(4) Rescheduled Date of Work
(5) Family Housing Office Point of Contact
(6) Family Housing Office Telephone
(7) Contractor's Point of Contact
(8) Contractor's Name and Telephone

1.12.6 Non-Availability of Work Areas

If the Contractor cannot gain entry into an occupied [building] [dwelling unit] after notifying the occupants twice; or the occupants refusal to [permit access to their unit] [vacate], the Contractor shall immediately notify the Contracting Officer for substitution and subsequent rescheduling of the [building] [dwelling unit].

1.12.7 Appliances and Major Furnishings

The Contractor shall move all appliances and major furnishings as necessary for accomp1ishing the work, and shall take appropriate measures to insure that existing flooring and items moved will not be damaged by such movement. [In occupied dwelling units, the Contractor shall reinstall or replace appliances and major furnishings in their original locations at the end of each work day, unless otherwise authorized by the Contracting Officer.]

1.12.8 Electricity and Water

In occupied dwelling units, electricity and running water shall be made available to the occupants during non-working hours and on weekends and holidays. [In addition, at least one water closet with running water will be made available for the private use of the occupants at all times including working hours.]

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PACIFIC OCEAN DIVISION GUIDE SPECIFICATION
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10/92

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SECTION 02090

REMOVAL AND DISPOSAL OF LEAD-CONTAINING PAINT
10/92

****
NOTES:
1. Refer to POD Engineer Technical Note 18, Guidance on Removal of Lead-Containing Paint (LCP).

2. This guide specification covers the requirements and procedures for limiting occupational and environmental exposure to lead when removing lead-containing paint. This guide specification is intended for use in projects where lead-containing paints must be removed from painted surfaces and it has been determined that the lead-containing paint is classified as hazardous waste in accordance with 40 CFR 261, Identification and Listing of Hazardous Waste, thereby requiring special handling, storage, and disposal according to federal and local hazardous waste management regulations.

3. This POD 4/92 section updates the Submittal Description (SD) numbers to accommodate the new Submittal Register Report.

4. Indicate on the project drawings:

5. Lead control area (area of lead-containing paint to be removed).

6. Designated boundary (area around lead control area).
****

PART 1 GENERAL

****
NOTE: See Additional Note A.
****

1.1 REFERENCES

****

NOTE: NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE, INC (ANSI)

ANSI Z9.2	(1979) Fundamentals Governing the Design and Operation of Local Exhaust Systems
ANSI Z88.2	(1980) Practices for Respiratory Protection Respiratory Protection

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910.134	(1988) Respiratory Protection
29 CFR 1910.1025	(1988) Lead
29 CFR 1910.1200	(1988) Hazard Communication
29 CFR 1926.55	Gases, Vapors, Fumes, Ducts, and Mists
29 CFR 1926.58	Ventilation
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Generators of Hazardous Waste
40 CFR 263	Transporters of Hazardous Waste
40 CFR 264	Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 268	1989 Land Disposal Restrictions
49 CFR 172	Hazardous Materials Tables and Hazardous Materials Communications Regulations
49 CFR 178	Shipping Container Specifications

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

HUD Guidelines	Lead-Based Paint; Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing

UNDERWRITERS LABORATORIES INC. (UL)

UL 586	1985 High-Efficiency, Particulate, Air Filter Units

STATE OF HAWAII DEPARTMENT OF LABOR & INDUSTRIAL RELATIONS

Occupational Safety and Health Standards, Chapter 202, # 12-202-33 Lead

1.2 DEFINITIONS

1.2.1 Action Level

Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8-hour period. As used in this section, "30 micrograms per cubic meter of air" refers to the action level.

1.2.2 Area Monitoring

Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations which may reach the breathing zone of personnel potentially exposed to lead.

1.2.3 Physical Boundary

Area physically roped or partitioned off around the structure and work area to limit unauthorized entry of personnel. As used in this Section, "inside boundary" shall mean the same as "outside lead control area."

1.2.4 Certified Industrial Hygienist (CIH)

As used in this section, refers to an Industrial Hygienist employed by the Contractor and is certified by the American Board of Industrial Hygiene in comprehensive practice.

1.2.5 Change Room and shower Facilities

Rooms within the designated physical boundary around the lead control area equipped with separate storage facilities for clean protective work clothing and equipment and for street clothes which prevent cross-contamination.

1.2.6 Decontamination Room

Room for removal of contaminated personal protective equipment (PPE).

1.2.7 Eight-Hour Time Weighted Average (TWA)

Airborne concentration of lead averaged over an 8-hour workday to which an employee is exposed.

1.2.8 High Efficiency Particulate Air (HEPA) Filter Equipment

HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron size particles.

1.2.9 Lead

Metallic lead, inorganic lead compounds, and organic lead soaps. Excluded from this definition are other organic lead compounds.

1.2.10 Lead Control Areas

An enclosed area or structure with full containment to prevent the spread of lead dust, paint chips, or debris of lead-containing paint removal operations. The lead control area is isolated by physical boundaries to prevent unauthorized entry of personnel.

1.2.11 Lead Permissible Exposure Limit (PEL)

Fifty micrograms per cubic meter of air as an 8-hour time weighted average as determined by 29 CFR 1910.1025. If an employee is exposed for more than 8 hours in a work day, the PEL shall be determined by the following formula:

PEL (micrograms/cubic meter of air) = 400/No. hrs worked per day

1.2.12 Personal Monitoring

Sampling of lead concentrations within the breathing zone of an employee to determine the 8-hour time weighted average concentration in accordance with 29 CFR 1910.1025. Samples shall be representative of the employee's work tasks. Breathing zone shall be considered an area within 12 inches of the nose or mouth of an employee.

1.3 QUALITY ASSURANCE

1.3.1 Medical Examinations

Before exposure to lead-contaminated dust, provide workers with a comprehensive medical examination as required by 29 CFR 1910.1025 and 29 CFR 1910.1200. The examination will not be required if adequate records show that employees have been examined as required by 29 CFR 1910.1025.

1.3.2 Medical Records

Maintain complete and accurate medical records of employees for a period of at least 40 years or for the duration of employment plus 20 years, whichever is longer.

1.3.3 CIH Responsibilities

a. Certify training.

b. Review and approve lead-containing paint removal plan for conformance to the applicable referenced standards.

c. Inspect lead-containing paint removal work for conformance with the approved plan.

d. Direct monitoring.

e. Ensure work is performed in strict accordance with specifications at all times.

f. Ensure hazardous exposure to personnel and to the environment are adequately controlled at all times.

1.3.4 Training

Train each employee performing paint removal and disposal work prior to the time of initial job assignment, in accordance with 29 CFR 1910.1025.

1.3.5 Respiratory Protection Program

a. Furnish each employee required to wear a negative pressure respirator with a respirator fit test at the time of initial fitting and at least every 6 months thereafter as required by 29 CFR 1910.1025 and 29 CFR 1926.55.

b. Establish and implement a respiratory protection program as required by ANSI Z88.2, 29 CFR 1910.134, 29 CFR 1910.1025, and 29 CFR 1926.55.

1.3.6 Hazard Communication Program

Establish and implement a Hazard Communication Program as required by 29 CFR 1910.1200.

1.3.7 Safety and Health Compliance

****
NOTE: Include applicable state, regional, and local laws, regulations, and statutes.
****

In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of federal, state, and local authorities regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1910.1025. Submit matters regarding interpretation of standards to the Contracting Officer for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply. [The following local laws, ordinances, criteria, rules and regulations regarding removing, handling, storing, transporting, and disposing of lead-contaminated materials apply:

a. [_____]

b. [_____]

c. [_____]]

1.3.8 Pre-Construction Conference

Along with the CIH, meet with the Contracting Officer to discuss in detail the lead-containing paint removal work plan, including work procedures and precautions for the work plan.

1.3.9 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FI0" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Vacuum Equipment; [____]. Respirators; [____]. Paint removal materials and applicable Material Safety Data Sheets; [____].

SD-08 Statements

Qualifications of CIH; [____].

Submit name, address, and telephone number of the CIH selected to perform responsibilities in paragraph entitled "CIH Responsibilities." Provide previous experience of the CIH. Submit proper documentation that the Industrial Hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification.

Lead-containing Paint Removal Plan; [____].

Submit a detailed job-specific plan of the work procedures to be used in the removal of lead-containing paint. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of shower facilities, and mechanical ventilation system. Include in the plan, eating, drinking, smoking and restroom procedures, interface of trades, sequencing of lead related work, collected wastewater and paint debris disposal plan, air sampling plan, respirators, protective equipment, and a detailed description of the method of containment of the operation to ensure that airborne lead concentrations of 30 micrograms per cubic meter of air are not exceeded. Include air sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of air monitoring personnel in the air sampling portion of the plan. Obtain approval of the plan prior to the start of paint removal work. [Include time, location and details of a two day trial monitoring period described in the paragraph entitled "Trial Monitoring".]

Rental Equipment Notification; [____].

Hazardous Waste Manifest; [____].

Completed and signed hazardous waste manifest from treatment or disposal facility.

Work Plan; [____].

CIH approval of work plan (signature, date, and certification number).

Respiratory Protection Program; [____].

Hazard Communication Program; [____].

Establish and implement a Hazard Communication Program as required by 29 CFR 1910.1200.

Disposal Facility; [____].

EPA approved hazardous waste treatment or disposal facility for lead disposal.

Hazardous Waste Management Plan; [____].

Submit a Hazardous Waste Management Plan within 45 calendar days after award of contract for Contracting Officer's approval. The Hazardous Waste Management plan shall comply with applicable requirements of federal, state, and local hazardous waste regulations and address:

a. Identification of hazardous wastes associated with the work.

b. Estimated quantities of wastes to be generated and disposed of.

c. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and a 24-hour point of contact. Furnish two copies of EPA hazardous waste permits.

d. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.

e. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.

f. Spill prevention, containment, and cleanup contingency measures to be implemented.

g. Work plan and schedule for waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.

h. Cost for hazardous waste disposal according to this plan.

Employee Training Certification; [____].

Submit certificates signed and dated by the CIH and by each employee stating that the employee has received training.

SD-09 Reports

Testing Laboratory; [____].

Submit the name, address, and telephone number of the testing laboratory selected to perform the monitoring, testing, and reporting of airborne concentrations of lead. Provide proper documentation that persons performing the analysis have been judged proficient by successful participation within the last year in the National Institute for Occupational Safety and Health (NIOSH) Proficiency Analytical Testing (PAT) Program. The laboratory shall be accredited by the American Industrial Hygiene Association (AIHA). Provide AIHA documentation along with date of accreditation/reaccreditation.

Monitoring Results; [____].

Submit air monitoring results to the Contracting Officer within 3 working days, signed by the testing laboratory employee performing the air monitoring, the employee that analyzed the sample, and the CIH. Submit copies of monitoring results to the contracting Officer.

SD-13 Certificates

Vacuum Filters; [____].

SD-18 Records

Manifest; [____].

Completed and signed hazardous waste manifest from treatment or disposal facility.

Certification of Medical Examination; [____]. EmployeeTraining Certification; [____]. Monitoring Results; [____].

1.4 REMOVAL

Materials resulting from demolition work, except as specified otherwise, shall be disposed of in accordance with Section 02050 DEMOLITION AND REMOVAL, except as specified herein.

1.5 EQUIPMENT

****

NOTE: Verify the number of sets required with Resident Engineer in charge.

****

Furnish the Contracting Officer with [two] [_____] complete sets of personal protective equipment daily, as required herein, for entry into and inspection of the paint removal work within the lead controlled area. Personal protective equipment shall include fitted respirators and disposable whole body covering, including appropriate foot, head, and hand protection. PPE shall remain the property of the Contractor.

1.5.1 Respirators

Furnish appropriate respirators approved by the NIOSH, Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1910.1025.

1.5.2 Special Protective Clothing

Furnish personnel who will be exposed to lead-contaminated dust with appropriate disposable protective whole body clothing, head covering, gloves, and foot coverings. Furnish appropriate disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CIH.

1.5.3 Rental Equipment Notification

If rental equipment is to be used during lead-containing paint handling and disposal, notify the rental agency in writing concerning the intended use of and a decontamination plan for the equipment. Furnish a copy of the written notification to the Contracting Officer.

1.5.4 Vacuum Filters

UL 586 labeled HEPA filters.

PART 2 PRODUCTS

2.1 PAINT REMOVAL PRODUCTS

Submit applicable Material Safety Data Sheets for paint removal products used in paint removal work. Use the least toxic product suitable for the job and acceptable to the Industrial Hygienist. The use of products that contain methylene chloride is prohibited due to its carcinogenicity.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Notification

Notify the Contracting Officer [20] [_____] days prior to the start of any paint removal work.

3.1.2 Lead Control Area Requirements

a. Establish a lead control area by completely enclosing with [containment screens] [___] the area or structure where lead-containing paint removal operations will be performed.

b. Contain removal operations by the use of a negative pressure full containment system with at least one change room and with HEPA filtered exhaust.

3.1.3 Protection of Existing Work to Remain

Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better.

3.1.4 Boundary Requirements

Provide physical boundaries around the lead control area by roping off the area [designated on the plans] or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.

3.1.5 Furnishings

****

NOTE: Verify with the activity furniture/equipment

requirements.
****
[The Government will remove furniture and equipment from the work area before lead-containing paint removal work begins.] [Furniture [_____] and equipment will remain in the building. Protect and cover furnishings or remove furnishings from the work area and store in a location approved by the Contracting Officer.]

3.1.6 Heating, Ventilating and Air Conditioning (HVAC) Systems

Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6-mil plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area. [Insure that HVAC intakes are protected or shut down during work.]

3.1.7 Change Room and Shower Facilities

Provide clean change rooms and shower facilities within the physical boundary around the designated lead control area in accordance with requirements of 29 CFR 1910.1025.

3.1.8 Mechanical Ventilation System

****
NOTE: Recirculation of HEPA filtered air from lead operations is not recommended.
****

a. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.58.

b. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters or other collection systems, approved by the industrial hygienist. Local exhaust ventilation systems shall be designed, constructed, installed, and maintained in accordance with ANSI Z9.2.

[c. If air from exhaust ventilation is recirculated into the work place, the system shall have a high efficiency filter with reliable back-up filter and controls to monitor the concentration of lead in the return air and to bypass the recirculation system automatically if it fails. Air may be recirculated only where exhaust to the outside is not feasible.]

3.1.9 Personnel Protection

Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been given appropriate training, protective equipment, and medical examinations.

3.1.10 Warning Signs

Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1910.1025.

3.2 WORK PROCEDURES

Perform removal of lead-containing paint in accordance with approved lead-containing paint removal plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-containing paint is removed in accordance with 29 CFR 1910.1025, except as specified herein. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), federal, state, and local requirements.

3.2.1 Personnel Exiting Procedures

Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:

a. Vacuum themselves off.

b. Remove protective clothing in the decontamination room, and place them in an approved impermeable disposal bag.

c. Properly decontaminate respirators and place HEPA filters in the approved impermeable disposal bag.

d. Shower.

e. Change to clean clothes prior to leaving the physical boundary designated around the lead-contaminated job site.

3.2.2 Monitoring

Monitoring of airborne concentrations of lead shall be in accordance with 29 CFR 1910.1025 and as specified herein. Air monitoring, testing, and reporting shall be performed by a CIH or an Industrial Hygiene (IH) Technician who is under the direction of the CIH.

a. The CIH or the IH Technician under the direction of the CIH shall be on the jobsite directing the monitoring, and inspecting the lead-containing paint removal work to ensure that the requirements of the Contract have been satisfied during the entire lead-containing paint removal operation. [The CIH shall be [located on the Island of Oahu] [___] during the entire lead-containing paint removal operation.

b. Take personal air monitoring samples on employees who are anticipated to have the greatest risk of exposure as determined by the CIH. In addition, take air monitoring samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.

c. Submit results of air monitoring samples, signed by the CIH, within 72 hours after the air samples are taken. Notify the Contracting Officer immediately of exposure to lead at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.

Perform personal and area monitoring during the entire paint removal operation. If the outside boundary lead levels are at or exceed 30 micrograms per cubic meter of air, the CIH shall immediately correct the condition(s) causing the increased levels and notify the Contracting

Officer immediately. The CIH shall review the sampling data collected on that day to determine if condition(s) requires any further change in work methods. Removal work shall resume when approval is given by the CIH. The Contractor shall control the lead level outside of the work boundary to less than 30 micrograms per cubic meter of air at all times. As a minimum, conduct area monitoring daily on each shift in which lead paint removal operations are performed in areas immediately adjacent to the lead control area. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area. If adjacent areas are contaminated, clean and visually inspect contaminated areas. The CIH shall certify that the area has been cleaned of lead contamination.

3.3 LEAD-CONTAINING PAINT REMOVAL

****
NOTE: See Note B located at rear of text.
****

[Manual or power sanding of interior and exterior surfaces is not permitted.] Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions are necessary to minimize damage to the underlying substrate.

3.3.1 Indoor Lead Paint Removal

3.3.1.1 Selection

****
NOTE: See Note C located at rear of text.
****

Select paint removal processes to minimize contamination of work areas with lead-contaminated dust or other lead-contaminated debris/waste. This paint removal process should be described in the lead-containing paint removal plan. [Perform manual sanding and scraping to the maximum extent feasible.]

3.3.1.2 Mechanical Paint Removal and Blast Cleaning

Perform mechanical paint removal and blast cleaning in lead control areas using negative pressure full containments with HEPA filtered exhaust. Collect paint residue and spent grit (use abrasive) from blasting operations for disposal in accordance with EPA, state and local requirements.

3.3.2 Outdoor Lead Paint Removal

****
NOTE: Use on a case-by-case basis after consulting with the local Industrial Hygienist for recommended practices, procedures, and precautions.
****

Select paint removal processes to minimize contamination of work areas with lead-contaminated dust or other lead-contaminated debris/waste. This paint removal process should be described in the lead-containing paint removal plan. [Perform manual sanding and scraping to the maximum extent feasible.]

3.4 CLEANUP AND DISPOSAL

3.4.1 Cleanup

****
NOTE: Verify with the local Industrial Hygienist if wet mopping of the work area and surfaces is necessary.
****

Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner [and wet mopping the area]. Control shall collect and contain lead paint.

3.4.2 Certification

The CIH shall certify in writing that the inside and outside the lead control area air monitoring samples are less than 30 micrograms per cubic meter of air, the respiratory protection for the employees was adequate, the work procedures were performed in accordance with 29 CFR 1910.1025, and that there were no visible accumulations of lead-contaminated paint and dust on the worksite. Clearance testing for lead dust is also required and will be accomplished in accordance with HUD Guidelines. Do not remove the roped-off boundary and warning signs prior to the Contracting Officer's receipt of the CIH's certification. Reclean areas showing dust or residual paint chips.

****
NOTE: Add testing if required to be performed by the Contractor.
****

3.4.3 Testing of Lead-Containing Paint Residue

[Where indicated or when directed by the Contracting Officer,] test lead containing paint residue in accordance with 40 CFR 261 for hazardous waste.

3.4.4 Disposal

****
NOTE: Notify the activity that Federal regulations (40 CFR 260-265) require a U.S. EPA generator identification number for use on the Uniform Hazardous Waste Manifest prior to commencement of removal work.
****
****
NOTE: Use this option if transportation and disposal has been arranged with the Installation Engineer. Verify procedures with the Installation Engineer.
****
****
NOTE: For POD Army projects, see Note D at end of text.
****

a. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing, which may produce airborne concentrations of lead particles.

b. Store removed paint, lead-contaminated clothing and equipment, and lead-contaminated dust and cleaning debris into U.S. Department of Transportation (49 CFR 178) approved 55-gallon drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date lead-contaminated wastes were first put into the drum. Obtain and complete the Uniform Hazardous Waste Manifest forms from [Activity Staff Civil Engineer located at [_____]] [_____]. Comply with land disposal restriction notification requirements as required by 40 CFR 268. At least 14 days prior to delivery, notify the Contracting Officer who will arrange for job site inspection of the drums and manifests by [Hazardous Waste Storage Facility personnel] [_____]. As necessary, make lot deliveries of hazardous wastes to the [PWC Hazardous Waste Storage Facility] [_____] to ensure that drums do not remain on the jobsite longer than 90 calendar days from the date affixed to each drum.

****

NOTE: Use this option if the Contractor is to dispose of hazardous waste.

****

****

NOTE: Research state, regional, and local laws, regulations, and statutes and revise the specifications accordingly.

****

a. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing which may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1910.1025. Dispose of lead-contaminated waste material at a [EPA] [or] [state] approved hazardous waste treatment, storage, or disposal facility off Government property.

****

NOTE: Hawaii does not have an EPA or State approved hazardous waste landfill.

****

b. Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55-gallon drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled. The Contracting Officer or an authorized representative will assign an area for interim storage of waste-containing drums. Do not store hazardous waste drums in interim storage longer than 90 calendar days from the date affixed to each drum.

c. Handle, store, transport, and dispose lead or lead-contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265.

3.4.5   Disposal Documentation

****

NOTE: Include the following paragraph if the Contractor is to dispose of hazardous waste.

****

Submit written evidence that the hazardous waste treatment, storage or disposal (TSD) facility is approved for lead disposal by the EPA and state or local regulatory agencies. Submit one copy of the completed manifest, signed and dated by the initial transporter in accordance with 40 CFR 262.

3.4.6 Payment for Hazardous Waste

Payment for disposal of hazardous waste will not be made until a signed copy of the manifest from the treatment or disposal facility certifying the amount of lead-containing materials delivered is returned and a copy is furnished to the Government.

-- End of Section --

CRITERIA NOTES

NOTE A: For additional information on the use of all CEGS, see CEGS-01000 CEGS GENERAL NOTES.

NOTE B: Use bracketed prohibition on manual and power sand when appropriate. Large scale manual or power sanding of painted surfaces should never be allowed in family housing, administrative buildings, galleys, barracks, etc., due to problems associated with the resulting dust fallout/contamination of crevices and cracks which may retain unseen quantities of lead-contaminated dust. Use of this type of removal technique for exteriors of the aforementioned facility types should be extremely limited, because the resulting airborne dust could result in significant contamination of the ground in the immediate vicinity of the facility. Manual or power sanding of interior and exterior surfaces may be an acceptable work method only if appropriate controls for personnel/environmental protection are in place.

NOTE C: Listed below are various types of paint removal techniques. Designer may be required to specify a particular technique in order to limit potential conflicts or problems.
1. Wood, Drywall, Interior Partitions

a. Scraping
b. Heat Stripping
c. Chemical Stripping
d. Power Tool Cleaning
e. Wet Blasting
2. Steel and Metal Surfaces (Industrial)

a. Power/Hand Tool Cleaning
b. Dry Abrasive Blast with Water Ring (Wet "Halo")
c. Wet Blast
d. Low Volume High Pressure Water Blast

NOTE D: Verify and arrange with the Installation Engineer prior to specifying hazardous waste disposal by the Government.

-- End --

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DEPARTMENT OF THE ARMY **HED-02091 (October 1992)**
U.S. ARMY CORPS OF ENGINEERS

PACIFIC OCEAN DIVISION GUIDE SPECIFICATION
****

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DIVISION 02 - SITE WORK

SECTION 02091

REMOVAL AND DISPOSAL OF SUBSTRATES WITH LEAD-CONTAINING PAINT

10/92

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****
DEPARTMENT OF THE ARMY **HED-02091 (October 1992)**
U.S. ARMY CORPS OF ENGINEERS **--------------------------**

PACIFIC OCEAN DIVISION GUIDE SPECIFICATION
****

SITE WORK

SECTION 02091

REMOVAL AND DISPOSAL OF SUBSTRATES WITH LEAD-CONTAINING PAINT
10/92

****

NOTES:

1. Refer to POD Engineer Technical Note 18, Guidance on Removal of Lead-Containing Paint (LCP).

2. This guide specification covers the requirements and procedures for limiting occupational and environmental exposure to lead when removing substrates with lead-containing paint. This guide specification is intended for use in projects where substrates with lead-containing paints will be removed from existing structures. It is also intended for use in total building demolition work. Delete all inappropriate paragraphs.

3. This POD 4/92 section updates the submittal Description (SD) numbers to accommodate the new Submittal Register Report.

4. Indicate on the project drawings:

5. Lead control area (area of lead-containing paint to be removed).

6. Designated boundary (area around lead control area).

****

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z88.2	(1980) Practices for Respiratory Protection

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910.134	(1988) Respiratory Protection
29 CFR 1910.1025	(1988) Lead
29 CFR 1910.1200	(1988) Hazard Communication
29 CFR 1926.55	Gases, Vapors, Fumes, Ducts, and Mists
40 CFR 261	Identification and Listing of Hazardous Waste

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

HUD Guidelines	Lead-Based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing.

1.2 DEFINITIONS

1.2.1 Action Level

Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8-hour period. As used in this section, "30 micrograms per cubic meter of air" refers to the action level.

1.2.2 Area Monitoring

Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations which may reach the breathing zone of personnel potentially exposed to lead.

1.2.3 Certified Industrial Hygienist (CIH)

As used in this section, refers to an Industrial Hygienist employed by the Contractor and is certified by the American Board of Industrial Hygiene in comprehensive practice.

1.2.4 Eight-Hour Time Weighted Average (TWA)

Airborne concentration of lead averaged over an 8-hour workday to which an employee is exposed.

1.2.5 Lead

Metallic lead, inorganic lead compounds, and organic lead soaps. Excluded from this definition are other organic lead compounds.

1.2.6 Lead Control Area

An enclosed area or structure to prevent the spread of debris of lead-containing paint. The lead control area is isolated by physical boundaries to prevent unauthorized entry of personnel.

1.2.7 Lead Permissible Exposure Limit (PEL)

Fifty micrograms per cubic meter of air as an 8-hour time weighted average as determined by 29 CFR 1910.1025. If an employee is exposed for more than 8 hours in a work day, the PEL shall be determined by the following formula:

PEL (micrograms/cubic meter of air) = 400/No. hrs worked per day

1.2.8 Personal Monitoring

Sampling of lead concentrations within the breathing zone of an employee to determine the 8-hour time weighted average concentration in accordance with 29 CFR 1910.1025. Samples shall be representative of the employee's work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches and the center at the nose or mouth of an employee.

1.3 QUALITY ASSURANCE

1.3.1 Medical Examinations

Before exposure to lead-contaminated dust, provide workers with a comprehensive medical examination as required by 29 CFR 1910.1025 and 29 CFR 1910.1200. The examination will not be required if adequate records show that employees have been examined as required by 29 CFR 1910.1025. Maintain complete and accurate medical records of employees for a period of at least 40 years or for the duration of employment plus 20 years, whichever is longer.

1.3.2 CIH Responsibilities

a. Direct monitoring

b. Ensure hazardous exposure to personnel and to the environment are adequately controlled at all times.

1.3.3 Training

Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment, in accordance with 29 CFR 1910.1025. Submit certificates signed and dated by the CIH and by each employee stating that the employee has received training.

1.3.4 Respiratory Protection Program

a. Furnish each employee a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least every six months thereafter as required by 29 CFR 1910.1025.

b. Establish and implement a respiratory protection program as required by ANSI Z88.2, 29 CFR 1910.134, 29 CFR 1910.1025, and 29 CFR 1926.55.

1.3.5 Pre-Construction Conference

Along with the CIH, meet with the Contracting Officer to discuss in detail the work procedures, precautions and monitoring to be employed.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation;

submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330, SUBMITTAL PROCEDURES:

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicated submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

SD-01 Data

Respirators, Manufacturer's Catalog Data; [____].

SD-08 Statements

Qualifications of CIH; [____].

Submit name, address and telephone number of the CIH selected to perform responsibilities in paragraph entitled "CIH Responsibilities". Provide previous experience of the CIH. Submit proper documentation that the Industrial Hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification.

Testing Laboratory; [____].

Submit the name, address and telephone number of the testing laboratory selected to perform the monitoring, testing and reporting of airborne concentrations of lead. Provide proper documentation that persons performing the analysis have been judged proficient by successful participation within the last year in the National Institute for Occupational Safety and Health (NIOSH) Proficiency Analytical Testing (PAT) Program. The laboratory shall be accredited by the American Industrial Hygiene Association (AIHA). Provide AIHA documentation along with date of accreditation/reaccreditation.

Lead-Containing Paint Work Plan; [____].

Submit a detailed job-specific plan of the work procedure to be used in work involving lead-containing paint. The plan shall include a sketch showing the location of lead control areas. Include in the plan, eating, drinking, smoking and restroom procedures, interface of trades, air sampling plan, and a procedure to stop work in the event air monitoring and laboratory analysis indicates PEL in excess of 50 micrograms per cubic meter of air. Indicate air sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of air monitoring personnel. Obtain approval of the plan prior to the start of work.

SD-09 Reports

Air Monitoring; [____].

Submit monitoring results to the Contracting Officer within 3 working days, signed by the testing laboratory employee performing the air monitoring, the employee that analyzed the sample, and the CIH.

SD-18 Records

a. Certification of Medical Examinations; [____].

b. Employee Training Certification; [____].

c. Monitoring Results; [____].

1.5 REMOVAL

Materials resulting from demolition work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of in accordance with Section 02050, DEMOLITION AND REMOVAL, provided that the material is not classified as hazardous waste in accordance with 40 CFR 261.

1.6 EQUIPMENT

****

NOTE: Verify the number of sets required with Resident Engineer in charge.

****

Furnish the Contracting Officer with [____] complete set(s) of personal protective equipment (PPE) daily as required for entry into and inspection of the work within the lead controlled area. PPE shall include fitted respirators and disposable whole body covering, including appropriate foot, head and hand protection. PPE shall remain the property of the Contractor.

1.6.1 Respirators

Furnish appropriate respirators approved by the NIOSH, Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1910.1025.

1.6.2 Special Protective Clothing

Furnish personnel who will be exposed to lead-contaminated dust with appropriate disposable protective whole body clothing, head covering, gloves and foot coverings.

PART 2 PRODUCTS (Not applicable)

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Lead Control Area Requirements

Establish a lead control area by completely enclosing with containment screens the area where work on lead-containing paint is to be performed.

3.1.2 Protection of Existing Work to Remain

Perform work on lead-containg paint without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore to its original condition or better.

3.1.3   Boundary Requirements

Provide physical boundaries around lead control area by roping off the area.

3.1.4   Furnishings

****
NOTE: Verify with the activity furniture/equipment requirements.
****

[The Government will remove furniture and equipment from the work area before work begins.] [Furniture and equipment will remain in the work area. Protect and cover furnishings or remove furnishings from the work area and store in a location approved by the Contracting Officer.]

3.1.5   Heating, Ventilation and Air Conditioning (HVAC) Systems

Shut down, lock out and isolate HVAC systems that supply, exhaust or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6-mil plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area.

3.1.6   Personnel Protection

Personnel shall wear respirators and use protective clothing and equipment as specified herein. Eating, smoking or drinking is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been given appropriate training and protective equipment. If the CIH certified monitoring tests covering a period of at least two days show the lead dust concentrations to be below the action level of 30 micrograms per cubic meter of air, the requirements for respirators, protective clothing and equipment, and containment will be waived. Contractor certification that controls, methods and operations which resulted in concentrations below 30 micrograms will remain in effect without change for the duration of the contract. If lead dust concentrations are at 30 to 49 micrograms per cubic meter of air, personnel protection requirements will remain in effect. If exposure to lead is at or in excess of the PEL of 50 micrograms per cubic meter of air, notify the Contracting Officer immediately and stop all work in the lead control area.

3.1.7   Warning Signs

Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1910.1025.

3.1.8   Monitoring

Monitoring of airborne concentrations of lead shall be in accordance with 29 CFR 1910.1025 and as specified herein. Air monitoring, testing and reporting shall be performed by a CIH or an Industrial Hygiene (IH)

Technician who is under the direction of the CIH.

****

a. The CIH or the IH Technician shall be on the jobsite directing the monitoring and inspecting the work on lead-containing paint to ensure that the requirements of the contract have been satisfied.

b. Take personal air monitoring samples on employees who are anticipated to have the greatest risk of exposure as determined by the CIH. Monitoring samples shall be taken on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift for at least two days.

c. Submit results of air monitoring samples, signed by the CIH, within 72 hours after the air samples are taken.

****

3.2 CLEANUP AND DISPOSAL

3.2.1 Cleanup

Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. At the end of each shift and when the work on lead contaminate d paint is completed, clean the area of visible lead paint contamination by vacuuming and wet mopping the area.

3.2.2 Certification

The CIH shall certify in writing that the inside and outside the lead control area air monitoring samples are less than 50 micrograms per cubic meter of air, the respiratory protection for the employees was adequate, the work procedures were performed in accordance with 29 CFR 1910.1025, and that there were no visible accumulations of lead-contaminated paint and dust on the worksite. Clearance testing for lead dust is also required and shall be accomplished in accordance with HUD Guidelines. Do not remove the lead control area or roped-off boundary and warning signs prior to the Contracting Officer's receipt of the CIH's certification. Reclean areas showing dust or residual paint chips.

3.2.3 Disposal

Disposal shall be in accordance with Section 02050, DEMOLITION AND REMOVAL, provided that the material is not classified as hazardous waste as determined by 40 CFR 261.

-- End of Section --

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DEPARTMENT OF THE ARMY | **HED-02092 (FEBRUARY 98)**
U.S. ARMY CORPS OF ENGINEERS | **-----------------------**
Superseding
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GUIDE SPECIFICATION FOR MILITARY CONSTRUCTION

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SECTION 02092

EXPOSURE ASSESSMENT FOR WORKERS EXPOSED TO LEAD-CONTAINING PAINT
02/98

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NOTE: This guide specification covers the requirements for layout of a CEGS. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-720.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE:

1. 29 CFR 1926.62 states, "This section applies to all construction work where an employee may be occupationally exposed to lead." No where in the CFR is a percent concentration of lead stated which can be used as a guide concentration that will cause an occupational exposure to lead. The CFR only provides that an exposure assessment must be conducted to determine if lead is a hazard, and until the exposure assessment is completed, all worker coming into contact with lead containing materials must be provided protection.

2. Thus where any amount of lead is discovered on the project site, even if lead is found to be below the concentrations designated as a hazard by HUD or by the Consumer Products Safety Council, lead must be considered a hazard until the exposure assessment is conducted. To aid in worker safety, the attached lead-containing specification shall be provided in such projects. This is the minimum requirement needed to protect workers and establishes the requirements for the exposure assessment.

3. Indicate on the project drawings:

4. Lead control area (area of lead-containing paint to be removed).

5. Designated boundard (area around lead control area).

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z88.2	(1980) Practices for Respiratory Protection

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910.134	(1988) Respiratory Protection
29 CFR 1926.51	Sanitation
29 CFR 1926.55	Gases, Vapors, Fumes, Ducts, and Mists
29 CFR 1926.59	(1993) Hazard Communication
29 CFR 1926.62	(1993) Lead Exposure in Construction
40 CFR 261	Identification and Listing of Hazardous Waste

STATE OF HAWAII OCCUPATIONAL SAFETY AND HEALTH STANDARDS

HIOSH 12-148	Lead in Construction

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

HUD Guidelines	Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing

1.2 DEFINITIONS

1.2.1 Action Level

Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8-hour period. As used in this section, "30 micrograms per cubic meter of air" refers to the action level.

1.2.2 Area Monitoring

Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations which may reach the breathing zone of personnel potentially exposed to lead.

1.2.3 Industrial Hygienist (IH):

The Industrial Hygienist shall have demonstratable experience in lead air monitoring techniques and in the establishment of a respiratory protection program for employees. The IH shall have working knowledge of applicable State and Federal occupational safety and health regulations for lead in construction. The IH shall have attended and completed Lead Abatement Supervision and Monitoring training and shall be considered a competent person as defined in 29 CFR 1926.62.

1.2.4 Industrial Hygiene Technician (IHT):

The industrial Hygiene Technician (IHT) shall be an employee of the IH or the testing laboratory and shall have a minimum of one (2) year experience in the industrial hygiene field working under the direction of the IH and has completed the following courses:

Lead Abatement Supervision and Monitoring-Covering practices and procedures in lead abatement, lead air sampling and abatement monitoring.

1.2.5 Eight-Hour Time Weighted Average (TWA)

Airborne concentration of lead averaged over an 8-hour workday to which an employee is exposed.

1.2.6 Lead

Metallic lead, inorganic lead compounds, and organic lead soaps. Excluded from this definition are other organic lead compounds.

1.2.7 Lead Control Area

An enclosed area or structure to prevent the spread of debris of lead-containing paint. The lead control area is isolated by physical boundaries to prevent unauthorized entry of personnel.

1.2.8 Lead Permissible Exposure Limit (PEL)

Fifty micrograms per cubic meter of air as an 8-hour time weighted average as determined by 29 CFR 1926.62 and HIOSH 12-148. If an employee is exposed for more than 8 hours in a work day, the PEL shall be determined by the following formula:

PEL (micrograms/cubic meter of air) = 400/No. hrs worked per day

1.2.9 Personal Monitoring

Sampling of lead concentrations within the breathing zone of an employee to determine the 8-hour time weighted average concentration in accordance with 29 CFR 1926.62 and HIOSH 12-148. Sample shall be representative of the employee's work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches and the center at the nose or mouth of an employee.

1.2.10 Exposure Assessment:

Each employer who has a workplace or operation covered by this standard shall initially determine if any employee may be exposed to lead at or above the action level. The exposure assessment shall be in accordance with 29 CFR 1926.62(d) and the employer shall provide interim worker protection in accordance with 29 CFR 1926.62(d)(2)(v).

1.3 Quality ASSURANCE

1.3.1 Medical Examinations

Before exposure to lead-contaminated dust, provide workers with a comprehensive medical examination as required by 29 CFR 1926.62 and HIOSH 12-148 and 29 CFR 1926.59. The examination will not be required if adequate records show that employees have been examined as required by 29 CFR 1926.62 and HIOSH 12-148. Maintain complete and accurate medical records of employees for a period of at least 40 years or for the duration of employment plus 20 years, whichever is longer.

1.3.2 IH Responsibilities

a. Direct monitoring.

b. Ensure hazardous exposure to personnel and to the environment are adequately controlled at all times.

c. Oversee IHT.

1.3.3 IHT Responsibilities

a. Conduct air monitoring of abatement personnel.

b. Ensure exposure to abatement personnel and the environment are adequately controlled at all times.

c. Ensure abatement personnel are conducting work in accordance with State and Federal occupational safety and health regulations.

d. Follow the instructions the senior industrial hygienist.

1.3.4 Training

Train each employee performing operations directly related to surface painted with lead-containing paint such as: paint removal, disposal, and air sampling operations prior to the time of initial job assignment, in accordance with 29 CFR 1926.62 and HIOSH 12-148 and 29 CFR 1926.59. Submit certificates signed and dated by the IH and by each employee stating that the employee has received training.

1.3.5 Respiratory Protection Program

a. Furnish each employee a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least every six months thereafter as required by 29 CFR 1926.62and HIOSH 12-148.

b. Establish and implement a respiratory protection program as required by ANSI Z88.2, 29 CFR 1910.134, 29 CFR 1926.62, HIOSH 12-148 and 29 CFR 1926.55.

1.3.6 Pre-Construction Conference

Along with the IH, meet with Contracting Officer to discuss in detail the work procedures, precautions and monitoring to be employed.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330, SUBMITTAL PROCEDURES:

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

SD-01 Data

Respirators, Manufacturer's Catalog Data; FIO.

SD-08 Statements

Qualifications of IH; GA.

Submit names, address and telephone number of the IH selected to perform responsibilities in paragraph entitled "IH Responsibilities". Provide previous experience of the IH. Submit proper documentation that the IH has at least 2 years experience in lead-based and lead-containing paint projects.

Testing Laboratory; GA.

Submit the name, address and telephone number of the testing laboratory selected to perform the monitoring, testing and reporting of airborne concentrations of lead. Provide proper documentation that persons performing the analysis have been judged proficient by successful participation within the last year in the National Institute for Occupational Safety and Health (NIOSH) Proficiency Analytical Testing (PAT) Program. The laboratory shall be accredited by the American Industrial Hygiene Association (AIHA). Provide AIHA documentation along with date of accreditation/reaccreditation.

Lead-Containing Paint Work Plan; GA.

Submit a detailed job-specific plan of the work procedures to be used in work involving lead-containing paint. The plan shall include a sketch showing the location of lead control areas. Include in the plan, eating, drinking, smoking and restroom procedures, interface of trades, air sampling plan, and a procedure to stop work in the event air monitoring and laboratory analysis indicates PEL in excess of 50 micrograms per cubic meter of air. Indicate air sampling, training and strategy, sampling methodology, frequency, duration of sampling and qualifications of air monitoring personnel. Obtain approval of the plan prior to the start of work.

SD-09 Reports

Exposure Assessment; GA.

Submit air monitoring results to the Contracting Officer with 3 working days, signed by the testing laboratory employee performing the air monitoring, the employee that analyzed the sample, and the IH.

SD-18 Records

a. Certification of Medical Examinations; FIO.

b. Employee Training Certification; FIO.

c. Monitoring Results; FIO.

1.5 REMOVAL

Materials resulting from demolition work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of in accordance with [Section 01900, MISCELLANEOUS PROVISIONS], [Section 02050, DEMOLITION] provided that the material is not classified as hazardous waste in accordance with 40 CFR 261.

1.6 EQUIPMENT

****

NOTE: Verify the number of sets required with Resident Engineer in charge.

****

Furnish the Contracting Officer with 2 complete set(s) of personal protective equipment (PPE) daily as required for entry into and inspection of the work within the lead controlled area. PPE shall include and disposable whole body covering, including appropriate foot, head and hand protection. PPE shall remain the property of the Contractor. The government shall provide their own fitted respirators when present on site.

1.6.1 Respirators

Furnish appropriate respirators approved by the NIOSH, Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1926.62 and HIOSH 12-148.

1.6.2 Special Protective Clothing

Furnish personnel who will be exposed to lead-contaminated dust with appropriate disposable protective whole body clothing, head covering, gloves and foot coverings.

1.6.3 Hygiene Facilities

The employer shall assure that in areas where employees are exposed to lead above the PEL without regard to use of respirators, food or beverage is not present or consumed, tobacco products are not present and used, and cosmetics are not applied.

1.6.4 Change Area

The employer shall provide clean change areas for employees if the exposure levels are above the PEL. The employer shall ensure the following:

a. A clean change area is provided for employees who are exposed to lead levels above the PEL.

b. A separate storage area to store personal protective clothing and street clothes separately to protect against cross contamination.

c. Employees do not leave the workplace wearing any protective clothing.

d. Shower facilities are provided for employees whose airborne lead exposure is above the PEL.

1.6.5 Hand Washing Facilities

The employer shall provide hand washing facilities for use by employees exposed to lead in accordance with 29 CFR 1926.51(f). The IHT shall ensure that employees wash hands before eating, drinking or smoking.

PART 2 PRODUCTS (Not applicable)

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Lead Control Area Requirements

Establish a lead control area by completely enclosing with containment screens the area where work on lead-containing paint is to be performed.

3.1.2 Protection of Existing Work to Remain

Perform work on lead-containing paint without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore to its original condition or better.

3.1.3 Boundary Requirements

Provide physical boundaries around lead control area by roping off the area.

3.1.4 Furnishings

****

NOTE: Verify with the activity furniture/equipment requirements.

****

The Government will remove furniture and equipment from the work area before work begins.

3.1.5 Personnel Protection

Personnel shall wear respirators and use protective clothing and equipment as specified herein. Eating, smoking or drinking is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been given appropriate training and protective equipment. If the IH certified monitoring tests covering a period of at least two days show the lead dust concentrations to be below the action level of 30 micrograms per cubic meter of air, the requirements for respirators, protective clothing and equipment, and containment will be waived.

Contractor certification that controls, methods and operations which resulted in concentrations below 30 micrograms will remain in effect without change for the duration of the contract. If lead dust concentrations are at 30 to 49 micrograms per cubic meter of air, personnel protection requirements will remain in effect. If exposure to lead is at or in excess of the PEL of 50 micrograms per cubic meter of air, notify the Contracting Officer immediately and stop all work in the lead control area.

3.1.6 Warning Signs

Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62 and HIOSH 12-148.

3.1.7 Monitoring

Monitoring of airborne concentrations of lead shall be in accordance with 29 CFR 1926.62 and HIOSH 12-148 and as specified herein. Air monitoring, testing and reporting shall be performed by an IH or an IHT who is under the direction of the IH.

a. The IH or the IHT shall be on the jobsite directing the monitoring and inspecting the work on lead-containing paint to ensure that the requirements of the contract have been satisfied.

b. Take personal air monitoring samples on employees who are anticipated to have the greatest risk of exposure as determined by the IH. Monitoring samples shall be taken on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift for at least two days.

c. Submit results of air monitoring samples, signed by the IH, within 72 hours after the air samples are taken. Two copies of the signed air monitoring results shall be provided. One copy shall be provided to the Contracting Officer and the second to the Pacific Ocean Division Safety Office, CEPOD-SO, Attention: Hilton Kalusche. As a minimum the exposure results shall provide the analytical results for each specific task where lead may be encountered, a description of the task (ex. sanding/scraping brown window trim paint), a description of the test area (ex. room number, hall or wing designation, building exterior, etc.), and the name and social security number of the person wearing the pump from which the sample was collected and analyzed for each particular task. The exposure results shall bear the contract number and name of the project as shown in the title block of the drawings.

3.2 CLEANUP AND DISPOSAL

3.2.1 Cleanup

Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. At the end of each shift and when the work on lead contaminated paint is completed, clean the area of visible lead paint contamination by vacuuming and wet mopping the area.

3.2.2 Certification

The IH shall certify in writing that the inside and outside the lead control area air monitoring samples are less than 50 micrograms per cubic meter of air, the respiratory protection for the employees was adequate, the work procedures were performed in accordance with 29 CFR 1926.62 and HIOSH 12-148, and that there were no visible accumulations of lead-contaminated paint and dust on the worksite. Clearance testing for lead dust is also required and shall be accomplished in accordance with HUD Guidelines. Do not remove the lead control area or roped-off boundary and warning signs prior to the Contracting Officer's receipt of the IH's certification. Reclean areas showing dust or residual paint chips.

3.2.3 Disposal

Disposal of lead-containing paint chips, dust, substrate painted with lead-containing paint and any other lead-containing debris shall be in accordance with Section 01900, MISCELLANOUE PROVISIONS, [Section 02050, DEMOLITION], provided that the material is not classified as hazardous waste as determined by 40 CFR 261.

3.3 TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP)

A Toxicity Characteristic Leaching Procedure (TCLP) shall be taken into accordance with the U.S. Army Hygiene Agency, sampling protocol, Building Demolition Debris and Buildings Painted with Lead-based paint. Analytical tests should be conducted for lead and cadmium. The landfill will request analytical data prior to disposal on Construction debris.

-- End of Section --

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DEPARTMENT OF THE ARMY	**CEGS-02220 (December 1997)**
U.S. ARMY CORPS OF ENGINEERS	**--------------------------**
	Superseding
	02050 (September 1991)

GUIDE SPECIFICATION FOR CONSTRUCTION

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02220

DEMOLITION
12/97

****
NOTE: This guide specification covers the requirements for demolition and removal of resulting debris. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: This specification will be edited to meet specific project requirements and coordinated with the appropriate sections; the bracketed spaces will be filled under paragraphs for environmental protection, UTILITIES, and FILLING.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ENGINEERING MANUALS (EM)

EM 385-1-1	(1996) U.S. Army Corps of Engineers Safety and Health Requirements Manual

1.2 GENERAL REQUIREMENTS

The work includes demolition, salvage of identified items and materials, and removal of resulting rubbish and debris. Rubbish and debris shall be removed from Government property daily, unless otherwise directed, to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Contracting Officer. In the interest of occupational safety and health, the work shall be performed in accordance with EM 385-1-1, Section 23, Demolition, and other applicable Sections. In the interest of conservation, salvage shall be pursued to the maximum extent possible; salvaged items and materials shall be disposed of as specified.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Work Plan; GA.

The procedures proposed for the accomplishment of the work. The procedures shall provide for safe conduct of the work, including procedures and methods to provide necessary supports, lateral bracing and shoring when required, careful removal and disposition of materials specified to be salvaged, protection of property which is to remain undisturbed, coordination with other work in progress, and timely disconnection of utility services. The procedures shall include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations in accordance with EM 385-1-1.

1.4 DUST CONTROL

The amount of dust resulting from demolition shall be controlled to prevent the spread of dust to occupied portions of the construction site and to avoid creation of a nuisance in the surrounding area. Use of water will not be permitted when it will result in, or create, hazardous or objectionable conditions such as ice, flooding and pollution.

1.5 PROTECTION

1.5.1 Protection of Personnel

During the demolition work the Contractor shall continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.5.2 Protection of Structures

Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, shall remain standing without additional bracing, shoring, of lateral support until demolished, unless directed otherwise by the Contracting Officer. The Contractor shall ensure that no elements determined to be unstable are left unsupported and shall be responsible for placing and securing bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

1.5.3 Protection of Existing Property

Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The Contractor shall take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the Government; any damaged items shall be repaired or replaced as approved by the Contracting Officer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

1.5.4 Protection From the Weather

The interior of buildings to remain; salvageable materials and equipment shall be protected from the weather at all times.

1.5.5 Protection of Trees

Trees within the project site which might be damaged during demolition, and which are indicated to be left in place, shall be protected by a 6 foot high fence. The fence shall be securely erected a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the work under this contract shall be replaced in kind or as approved by the

Contracting Officer.

1.5.6 Environmental Protection

The work shall comply with the requirements of Section [01410 ENVIRONMENT PROTECTION] [_____].

1.6 BURNING

The use of burning at the project site for the disposal of refuse and debris [will not be permitted] [will be permitted in the area located [_____] and between the hours of [_____] and [_____]].

1.7 USE OF EXPLOSIVES

Use of explosives [will] [will not] be permitted.

1.8 AVAILABILITY OF WORK AREAS

Areas in which the work is to be accomplished will be available in accordance with the following schedule:

Area	Date
[_____]	[_____]

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 EXISTING STRUCTURES

Existing structures indicated shall be removed [to grade] [to top of foundation walls] [to [_____] feet below grade]. Interior walls, other than retaining walls and partitions, shall be removed to [_____] feet below grade or to top of concrete slab on ground. Basement slabs shall be broken up to permit drainage. Sidewalks, curbs, gutters and street light bases shall be removed as indicated.

3.2 UTILITIES

Disconnection of utility services, with related meters and equipment, are specified in Section [_____]. Existing utilities shall be removed as indicated. When utility lines are encountered that are not indicated on the drawings, the Contracting Officer shall be notified prior to further work in that area.

3.3 FILLING

Holes, open basements and other hazardous openings shall be filled in accordance with Section [_____] [as follows: [_____]].

3.4 DISPOSITION OF MATERIAL

Title to material and equipment to be demolished, except Government salvage and historical items, is vested in the Contractor upon receipt of notice to proceed. The Government will not be responsible for the condition, loss or damage to such property after notice to proceed.

3.4.1 Salvageable Items and Material

Contractor shall salvage items and material to the maximum extent possible.

3.4.1.1 Material Salvaged for the Contractor

Material salvaged for the Contractor shall be stored as approved by the Contracting Officer and shall be removed from Government property before completion of the contract. Material salvaged for the Contractor shall not be sold on the site.

3.4.1.2 Items Salvaged for the Government

Salvaged items to remain the property of the Government shall be removed in a manner to prevent damage, and packed or crated to protect the items from damage while in storage or during shipment. Items damaged during removal or storage shall be repaired or replaced to match existing items. Containers shall be properly identified as to contents. The following items reserved as property of the Government shall be delivered to the areas designated: [_____].

3.4.1.3 Items Salvaged for the Using Service

The following items reserved as property of the using service shall be removed prior to commencement of work under this contract: [_____].

3.4.1.4 Historical Items

Historical items shall be removed in a manner to prevent damage. The following historical items shall be delivered to the Government for disposition: Corner stones, contents of corner stones, and document boxes wherever located on the site.

3.4.2 Unsalvageable Material

Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed of in the disposal area located [_____]. The fill in the disposal area shall remain below elevation [_____] and after disposal is completed, the disposal area shall be uniformly graded to drain. Combustible material shall be disposed of [in the sanitary fill area located [_____]] [off the site] [by burning].

3.5 CLEAN UP

Debris and rubbish shall be removed from basement and similar excavations. Debris shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

3.6 PAVEMENTS

Existing pavements designated for removal shall be saw cut and removed in accordance with the details shown on the drawings and to the limits and [depths indicated on the drawings] [to a depth of [_____] inches].

-- End of Section --

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DEPARTMENT OF THE ARMY **HED-02315 (April 1999)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**
Superseding
CEGS-02315 (August 1998)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

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04/99

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SECTION 02315

EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS
04/99

****

NOTE: This guide specification covers the requirements for excavation, filling and backfilling, dewatering, shoring, and grading for building construction. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-700.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for drainage and dewatering, shoring, blasting, and utility and drain trenches. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****

NOTE: This guide specification does not include provisions for separate measurement and payment for any work specified herein. Measurement and payment paragraphs may be provided in the contract specifications when unit-price payment is more equitable for rock excavation, borrow excavation,

and the removal and replacement of unsatisfactory material below grades indicated. This section includes requirements for clearing, grubbing, stripping, grading, and topsoiling. If the contract specifications contain separate sections on clearing, grubbing, grading and turf establishment, this section will be revised accordingly.

ASTM reference standards may be replaced by appropriate AASHTO reference standards when matching local practice.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIAL (AASHTO)

AASHTO T 180 (1993) Moisture-Density Relations of Soils Using a 10-1b. (4.54 kg) Rammer and a 18-inch (457 mm) Drop

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 117 (1987) Materials Finer than 75 um (No. 200) Sieve in Mineral Aggregates by Washing

ASTM C 136 (1984) Sieve Analysis of Fine and Coarse Aggregates

ASTM D 422 (1972) Particle-Size Analysis of Soils

ASTM D 1556 (1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 1557 (1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))

ASTM D 2216 (1992) Laboratory Determination of Water (Moisture) Content of Soil, and Rock

ASTM D 2487 (1993) Classification of Soils for Engineering Purposes (Unified Soil

	Classification System)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 2937	(1994) Density of Soil in Place by the Drive-Cylinder Method
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 4253	(1993) Maximum Index Density and Unit Weight of Soils Using a vibratory Tables
ASTM D 4318	(1995a) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4718	(1987) Practice for Correction of Unit Weight and Water Content for Soils Containing Oversized Particles

1.2 DEGREE OF COMPACTION

****
NOTE: ASTM D 1557 may not be applicable for certain free-draining types of soils, in which case the applicable requirements will be substituted. See ASTM D 1557 for details.
****

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557-91, Method C, for material that has no more than 30 percent retained on the 3/4 inch sieve and has more than 20 percent retained on the 3/8 inch sieve. Where the material does not meet these gradation requirements, AASHTO T 180 method D will be used. Where free draining soils, i.e., sand or gap-graded aggregate are to be compacted, use ASTM D 4253. The procedure will be abbreviated below as a percentage of laboratory density.

1.3 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-09 Reports

Testing; [_____].

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Satisfactory Materials

****

NOTE: Satisfactory material will be defined in accordance with locally available materials, climatic and water conditions prevailing onsite, economic limitations of the project, design slopes, etc., and suitable classes, based on the geotechnical report, will be listed in the project specification in accordance with the Unified Soil Classification System, ASTM D 2487.

NOTE: Consult the geotechnical report to determine satisfactory material intended for this section of Specifications. Where on-site materials may not meet the definition of satisfactory material (e.g. residual soils at Schofield Barracks) but exhibits very low expansive characteristics and considered satisfactory for the intended project, the second bracketed paragraph may be considered.

****

[Materials classified in ASTM D 2487 as GW, GP, GM, GC, SW, SP, SM, SC, (ML, MH, and CL) and free from roots and other organic matter, trash, debris and stones larger than 6 inches in any dimension are satisfactory. In addition, satisfactory materials shall have liquid limits less than 60 and plasticity indexes less than 30. Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.

[On-site excavated materials are satisfactory materials for fills and backfills. Imported materials classified in ASTM D 2487 as GW, GP, GM, GC, SW, SP, SM, SC, (ML, MH, and CL) and free from roots and other organic matter, trash, debris, and stones larger than 3 inches in any dimension are satisfactory. In addition, imported satisfactory materials shall have liquid limits less than 50 and plasticity indexes less than 30. Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.]

2.1.2 Unsatisfactory Materials

****

NOTE: Unsatisfactory material will be defined in accordance with locally available materials, design

slopes, etc., and unsuitable classes will be listed in the project specifications in accordance with ASTM D 2487. Normally, stones larger than 75 mm (3 inches) are considered unsatisfactory. This paragraph should be edited to delete inapplicable materials.

****

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, frozen material, and stones larger than [_____] inches. The Contracting Officer shall be notified of any contaminated materials.

2.1.3 Cohesionless and Cohesive Materials

****

NOTE: When classification will be necessary during construction, determination of grain size for classification will be specified to be made in conformance with the following:

ASTM C 117: (1995) Materials Finer than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing

ASTM C 136: (1996a) Sieve Analysis of Fine and Coarse Aggregates

ASTM D 422: (1963; R 1990) Particle-Size Analysis of Soils

****

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM, GP-GM, GW-GM, SW-SM, SP-SM, and SM shall be identified as cohesionless only when the fines are nonplastic. Testing required for classifying materials shall be in accordance with [ASTM C 117] [ASTM C 136] [ASTM D 422] and [ASTM D 4318] as applicable.

2.1.4 Expansive Soils

****

NOTE: Additional laboratory testing and analysis might be needed to better define site specific expansive soils. If expansive soils are anticipated at the construction site, this specification should be edited to ensure proper construction techniques are undertaken per TM 5-818-7.

****

Expansive soils are defined as soils that have a plasticity index equal to or greater than 30 [___] when tested in accordance with ASTM D 4318.

2.2 CAPILLARY WATER BARRIER

Capillary Water Barrier shall consist of clean, crushed, nonporous rock, crushed gravel, or uncrushed gravel. The maximum particle size shall be 1-1/2 inches and no more than 2 percent by weight shall pass the No. 4 size sieve.

PART 3 EXECUTION

3.1 CLEARING AND GRUBBING

****

NOTE: When clearing and grubbing are specified in another section, use the sentence in the first set of brackets. Otherwise use the remainder of the paragraph.

****

[Clearing and grubbing is specified in Section 02230 CLEARING AND GRUBBING.] [The areas within lines 5 feet outside of each building and structure line shall be cleared and grubbed of trees, stumps, roots, brush and other vegetation, debris, existing foundations, pavements, utility lines, structures, fences, and other items that would interfere with construction operations. Stumps, logs, roots, and other organic matter shall be completely removed and the resulting depressions shall be filled with satisfactory material, placed and compacted in accordance with paragraph FILLING AND BACKFILLING. Materials removed shall be disposed of [in the designated waste disposal areas] [outside the limits of Government-controlled property at the Contractor's responsibility].]

3.2 TOPSOIL

Topsoil shall be stripped to a depth of [_____] inches below existing grade within the designated excavations and grading lines and deposited in storage piles for later use. Excess topsoil shall be disposed as specified for excess excavated material.

3.3 EXCAVATION

Excavation shall conform to the dimensions and elevations indicated for each building, structure, and footing except as specified, and shall include trenching for utility and foundation drainage systems to a point 5 feet beyond the building line of each building and structure, excavation for [outside grease interceptors] [, underground fuel tanks,] [and] all work incidental thereof. Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory material encountered below the grades shown shall be [removed as directed] [replaced with satisfactory material; and payment will be made in conformance with the CHANGES clause of the CONTRACT CLAUSES.] Satisfactory material removed below the depths indicated, without specific direction of the Contracting Officer, shall be replaced, at no additional cost to the Government, with satisfactory materials to the indicated excavation grade; except that concrete footings shall be increased in thickness to the bottom of the overdepth excavations and over-break in rock excavation. Satisfactory material shall be placed and compacted as specified in paragraph FILLING AND BACKFILLING.

Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated shall be done under the direction of the Contracting Officer.

3.4 DRAINAGE AND DEWATERING

3.4.1 Drainage

Surface water shall be directed away from excavation and construction sites to prevent erosion and undermining of foundations. Diversion ditches, dikes and grading shall be provided and maintained as necessary during construction. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

3.4.2 Dewatering

****
NOTE: This paragraph will be revised as needed when specific methods of dewatering are required.
****

Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, at least [_____] feet below the working level.

3.5 SHORING

Shoring, including sheet piling, shall be furnished and installed as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Shoring, bracing, and sheeting shall be removed as excavations are backfilled, in a manner to prevent caving.

3.6 CLASSIFICATION OF EXCAVATION

[Excavation will be unclassified regardless of the nature of material encountered.] [Rock excavation shall consist of the removal and disposal of boulders 1 cubic yard or more in volume; solid rock; materials that cannot be removed without systematic drilling and blasting such as rock material in ledges or aggregate conglomerate deposits that are so firmly cemented as to possess the characteristics of solid rock; and concrete or masonry structures exceeding 1 cubic yard in volume, except sidewalks and paving. Hard and compact materials such as cemented gravel, glacial till, and relatively soft or disintegrated rock that can be removed without continuous and systematic drilling and blasting will not be considered as rock excavation. Rock excavation will not be considered as such because of intermittent drilling and blasting that is performed merely to increase production. Excavation of the material claimed as rock shall not be performed until the material has been cross sectioned by the Contractor and approved by the Contracting Officer. Common excavation shall consist of all excavation not classified as rock excavation.]

3.7 BLASTING

Blasting [will] [will not] be permitted.

3.8 UTILITY AND DRAIN TRENCHES

Trenches for underground utilities systems and drain lines shall be excavated to the required alignments and depths. The bottoms of trenches shall be graded to secure the required slope and shall be tamped if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 6 inches below the bottom of the pipe, and the overdepth shall be backfilled with satisfactory material placed and compacted in conformance with paragraph FILLING AND BACKFILLING.

3.9 BORROW

****

NOTE: Cross reference must be coordinated with Section 02300 EARTHWORK.

Coordinate this paragraph with the requirements of paragraph EXCAVATED MATERIALS.

****

Where satisfactory materials are not available in sufficient quantity from required excavations, approved materials shall be obtained as specified in Section [02300 EARTHWORK] [_____].

3.10 EXCAVATED MATERIALS

****

NOTE: When spoil areas or borrow areas are within the limits of Government-controlled land, additional requirements based on the following, and as appropriate for the project, will be included in the contract document. Locations of areas will be indicated, or the approximate distances from the project site will be specified. Generally, unburned vegetative material and surplus excavated material will be disposed of in inconspicuous spoil areas where no future construction is planned. If economically justifiable, surplus suitable excavated material may be stockpiled or may be disposed of in areas where future construction is planned and where fill will be required. Spoil materials will be so placed and the worked portions of spoil areas and borrow areas will be so graded and shaped as to minimize soil erosion, siltation of drainage channels, and damage to existing vegetation. The degree of compaction will be specified.

****

Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required under this section or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed of as specified in Section [02300 EARTHWORK] [_____].

3.11 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Excavation to final grade shall not be made until just before concrete is to be placed. [For pile foundations, the excavation shall be stopped at an elevation of from 6 to 12 inches above the bottom of the footing before driving piles. After pile driving has been completed, the remainder of the excavation shall be completed to the elevations shown.] Only excavation methods that will leave the foundation rock in a solid and unshattered condition shall be used. Approximately level surfaces shall be roughened, and sloped surfaces shall be cut as indicated into rough steps or benches to provide a satisfactory bond.

If footings are formed, the remaining annulus between the footing edge and excavation face should be wide enough to allow hand-held equipment to compact the backfill material. Surfaces that become wet or muddy should be remediated by drying the surface and recompacting or removing the wet material. Surfaces that become dried out and cracked should be remediated by moisture conditioning and recompacting the surface.

3.12 SUBGRADE PREPARATION

Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials as directed by the Contracting Officer. The surface shall be scarified to a depth of 6 inches before the fill is started. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 6 inches, pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches and compacted as specified for the adjacent fill. Material shall not be placed on surfaces that are muddy. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary [to plus or minus [_____] percent of optimum moisture] [to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used]. Minimum subgrade density shall be as specified in paragraph FILLING AND BACKFILLING. [The subgrade beneath building slabs-on-grade shall be kept continually moist for at least 5 days prior to placement of the CWB.]

3.13 FILLING AND BACKFILLING

****

NOTE: It is imperative to specify a high degree of compaction in fills under structures to minimize settlement and to insure stability of a structure. In addition to the criteria set forth in TM 5-818-1, the following factors will be considered in establishing the specific requirements:

a. The sensitivity of the structure to total and/or differential settlement as related to the structural design. This is particularly true of structures to be founded partly on fill and partly on natural ground.

b. The ability of normal compaction equipment to produce the desired densities in existing or locally available materials within a reasonable range of molding moisture content. If considered essential, special equipment will be specified.

c. The compaction requirements for clean, cohesionless, granular materials will be generally higher than those for cohesive materials because cohesionless materials readily consolidate when subjected to vibration. For structures with critical stability requirements and settlement limitations, the minimum density requirements may be altered. If only a cohesionless soil or only a cohesive soil is used, the inapplicable values will be deleted.

d. The exception to required high degree of compaction in fills and backfills is in expansive soils (see TM 5-818-7). Where it is necessary to use materials having swelling characteristics, usually CL or CH classifications, the specified degree of compaction will be related to laboratory test results for swelling under a considerable range of molding moisture and compactive effort. In swelling soils, it is important to specify a density and molding moisture range that will enable the soil to stay stable, striking a reasonable balance between potential swell and excessive settlement under load, even at the expense of accepting a reduced bearing capacity. A maximum permissible density should be established to minimize swelling. If possible, soils with swelling characteristics will be classified as unsatisfactory material, particularly under critical stability structures.

e. ASTM D 1557 is satisfactory for establishing moisture density characteristics of a material in most cases. However, other modifications may be necessary as discussed in this ASTM and under soil tests in DM 21.3/ TM 5-825-2. The procedures and precautions in the subgrade compaction paragraphs of DM 21.3/TM 5-825-2, will be considered in establishing minimum density requirements for a particular project.

Modifications will be made to meet the backfill requirements for deep-seated or subsurface

structures as discussed in TM 5-818-4.
****

Satisfactory materials shall be used in bringing fills and backfills to the lines and grades indicated and for replacing unsatisfactory materials. Satisfactory materials shall be placed in horizontal layers not exceeding 8 inches in loose thickness, or 6 inches when hand-operated compactors are used. After placing, each layer shall be plowed, disked, or otherwise broken up, moistened or aerated as necessary [to a moisture content at least 3 percent above optimum], thoroughly mixed and compacted as specified. Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade [and shall include backfill for outside grease interceptors and underground fuel tanks]. Backfill shall not be placed in wet areas. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 2 feet above sewer lines and 1 foot above other utility lines shall be free from stones larger than 1 inch in any dimension. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Backfill shall not be placed against foundation walls prior to 7 days after completion of the walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall. Each layer of fill and backfill shall be compacted to not less than the percentage of maximum density specified below:

	Percent Laboratory maximum density	
	Cohesive material	Cohesionless material
Fill, embankment, and backfill		
Under structures, building slabs, steps, paved areas, around footings, and in trenches	90	95
Under sidewalks and grassed areas	90	90
[Expansive materials	Compacted to not less than [_____] percent nor more than [_____] percent]	
Nonfrost susceptible materials		95
Subgrade		
Under building slabs, steps, and paved areas, top 12 inches	90	95

	Percent Laboratory maximum density	
	Cohesive material	Cohesionless material
Under sidewalks, top 6 inches	90	90

Approved compacted subgrades that are disturbed by the Contractor's operations or adverse weather shall be scarified and compacted as specified herein before to the required density prior to further construction thereon. Recompaction over underground utilities and heating lines shall be by hand tamping.

3.14 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or may be performed by the Contractor subject to approval. Field in-place density shall be determined in accordance with [ASTM D 1556] or [ASTM D 2922]. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted if necessary by the procedure described in ASTM D 2922, paragraph ADJUSTING CALIBRATION CURVE. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

Copies of [Calibration curves, results of calibration tests, and] field and laboratory density tests shall be furnished to the Contracting Officer within 24 hours of conclusion of the tests.

3.14.1 In-Place Densities

In-place density and moisture content test results shall be included with the Contractor's daily construction quality control reports.

3.14.1.1 In-Place Density of Subgrades

One test per [_____] square foot or fraction thereof.

3.14.1.2 In-Place Density of Fills and Backfills

One test per [_____] square foot or fraction thereof of each lift for fill or backfill areas compacted by other than hand or hand-operated machines. The density for each lift of fill or backfill materials for trenches, pits, building perimeters or other structures or areas less than [_____] feet in width, which are compacted with hand or hand-operated machines shall be tested as follows: One test per each area less than [_____] square feet, or one test for each [_____] linear foot of long narrow fills [_____] feet or more in length. [If ASTM D 2922 is used, in-place densities shall be checked by ASTM D 1556 as follows: One check for every ten (10) nuclear tests, or fraction thereof.

3.14.2   Moisture Content

In the stockpile, excavation or borrow areas, a minimum of two tests per day per type of material or source of materials being placed is required during stable weather conditions. During unstable weather, tests shall be made as dictated by local conditions and approved moisture content shall be tested in accordance with ASTM D 2216.

3.14.3   Optimum Moisture and Laboratory Maximum Density

Tests shall be made for each type material or source of material, including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per [_____] cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density will be made.

3.15   CAPILLARY WATER BARRIER

****
NOTE: The compacted thickness of capillary water barrier will be indicated and will not be less than 100 mm (4 inches). The paragraph will be deleted where site conditions make the barrier unnecessary.
****

Capillary water barrier under concrete floor and area-way slabs on grade shall be placed directly on the subgrade and shall be compacted with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.16   GRADING

Areas within 5 feet outside of each building and structure line shall be constructed true-to-grade, shaped to drain, and shall be maintained free of trash and debris until final inspection has been completed and the work has been accepted.

3.17   SPREADING TOPSOIL

Areas outside the building lines from which topsoil has been removed shall be topsoiled. The surface shall be free of materials that would hinder planting or maintenance operations. The subgrade shall be pulverized to a depth of 2 inches by disking or plowing for the bonding of topsoil with the subsoil. Topsoil shall then be uniformly spread, graded, and compacted to the thickness, elevations, slopes shown, and left free of surface irregularities. Topsoil shall be compacted by one pass of a cultipacker, roller, or other approved equipment weighing 100 to 160 pounds per linear foot of roller. Topsoil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to seeding, planting, or proper grading.

3.18   PROTECTION

Settlement or washing that occurs in graded, topsoiled, or backfilled areas prior to acceptance of the work, shall be repaired and grades reestablished to the required elevations and slopes.

[Excavation surfaces or finish subgrades shall be protected from drying out and cracking by keeping the surface continuously moist until concrete pours or placement of base course and vapor barrier. If excavation surfaces become wet or muddy the surface shall be dried and recompacted or the wet material removed.]

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-02316 (November 1997)**
U.S. ARMY CORPS OF ENGINEERS | **--------------------------**
Superseding
CEGS-02222 (July 1989)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 3 (August 1999)
Includes Special Change (Tailoring Options) (July 1998)
Includes Text Adjustment Change (Section References) (November 1998)

Latest change indicated by CHG tags
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DIVISION 02 - SITE WORK

SECTION 02316

EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS

11/97

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DEPARTMENT OF THE ARMY **CEGS-02316 (November 1997)**
U.S. ARMY CORPS OF ENGINEERS **--------------------------**
Superseding
CEGS-02222 (July 1989)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 3 (August 1999)
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Latest change indicated by CHG tags
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SECTION 02316

EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS
11/97

****
NOTE: This guide specification covers the requirements for excavation, trenching, and backfilling for utilities systems to the points of connection within 1.5 m (5 feet) of the buildings. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for rock excavation, and sheeting and bracing. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.2 MEASUREMENT AND PAYMENT

****
NOTE: These paragraphs are written for bids on a unit-price basis. When it is determined that a lump-sum contract may be more advisable, these paragraphs will be deleted.
****

Measurement and payment shall be based on completed work performed in accordance with the drawings and specifications.

1.2.1 Trench Excavation

****
NOTE: This paragraph will be coordinated with the payment paragraphs of appropriate contract sections to ensure that there are no dual payments or omission of payment for trench excavation. There should be separate payment items established for trench excavation for each different size of pipe in the contract. Payment for trench excavation for

heat-distribution system and for underground electrical-distribution system may be excluded for payment from this paragraph, and included in payment under the appropriate utility section, when the work is of such a nature and extent and so clearly indicated that the excavation quantities involved can be estimated with reasonable accuracy.
****

Trench excavation shall be the number of linear feet measured along the centerline of the trench and excavated to the depths and widths specified for the particular size of pipe. No increase shall be made for the extra width required at manholes and similar structures. Payment for trench excavation, as so measured, shall constitute full payment for excavation and backfilling, [including specified overdepth] except in rock or unstable trench bottoms. Unstable trench bottoms shall be replaced by select granular material and paid for as specified below. Trench excavation shall also include the additional width at manholes and similar structures, the furnishing, placing and removal of sheeting and bracing, pumping and bailing, and all incidentals necessary to complete the work required by this section.

1.2.2 Rock Excavation

Rock excavation shall be measured and paid for by the number of cubic yards of acceptably excavated rock material. The material shall be measured in place, but volume shall be based on a maximum 30 inch width for pipes 12 inches in diameter or less, and a maximum width of 16 inches greater than the outside diameter of the pipe for pipes over 12 inches in diameter. The measurement shall include all authorized overdepth rock excavation as determined by the Contracting Officer. For manholes and other appurtenances, volumes of rock excavation shall be computed on the basis of 1 foot outside of the wall lines of the structures. Payment for rock excavation will be made in addition to the price bid for the trench excavation, and will include all necessary drilling and blasting and all incidentals necessary to excavate and dispose of the rock. Backfill replacing rock excavation will not be paid for separately, but will be included in the unit price for rock excavation.

1.2.3 Sheeting and Bracing

Sheeting and bracing, when shown or authorized by the Contracting Officer to be left in place, will be paid for as follows: [_____].

1.2.3.1 Timber Sheeting

Timber sheeting will be paid for as the number of board feet of lumber below finish grade measured in place prior to backfilling. Sheeting wasted when cut off between the finished grade and 1 foot below the finished grade also shall be included in the measurement.

1.2.3.2 Steel Sheeting and Soldier Piles

****
NOTE: The blank will be filled with an appropriate number not greater than 1 meter (3 feet). However, if the quantities of sheeting involved are anticipated to be substantial, and since the cut off

steel can be sold by the Contractor as scrap, the whole part in brackets can be deleted and no payment provided for wasted cut off ends.
****

Steel sheeting, soldier piles, and steel bracing will be paid for according to the number of pounds of steel calculated. This calculation shall be made by multiplying the measured in-place length in feet below finish grade by the unit weight of the section in pounds per foot. Unit weight of rolled steel sections shall be obtained from recognized steel manuals. [Sheeting wasted when cut off between the finished grade and a distance of up to [_____] feet below the finished grade shall be included in the measurement.]

1.2.4 Select Granular Material

Select granular material shall be measured in place as the actual cubic yards replacing wet or unstable material in trench bottoms [within the limits shown] [in authorized overdepth areas]. The unit price shall include furnishing and placing the granular material, excavation and disposal of unsatisfactory material, and additional requirements for sheeting and bracing, pumping, bailing, cleaning, and other incidentals necessary to complete the work. Payment for select granular material will be made in addition to the bid price for trench excavation.

1.3 DEGREE OF COMPACTION

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

1.4 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-09 Reports

Field Density Tests; [_____]. Testing of Backfill Materials; [_____].

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Satisfactory Materials

****
NOTE: Satisfactory material will be defined in accordance with locally available materials, type of installation, etc., and suitable classes, based on the geotechnical report, will be listed in the contract specification in accordance with the Unified Soil Classification System (ASTM D 2487).
****

Satisfactory materials shall comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, [SM,] [SW-SM,] [SC,] [SW-SC,] [SP-SM,] [SP-SC,] [CL,] [ML,] [CL-ML,] [CH,] [MH].

2.1.2 Unsatisfactory Materials

****
NOTE: Unsatisfactory material will be defined in accordance with locally available materials, type of installation, etc., and unsuitable classes will be listed in the project specification in accordance with ASTM D 2487. Normally, stones larger than 75 mm (3 inches) are considered unsatisfactory. This paragraph should be edited to delete inapplicable materials.
****

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, frozen material, and stones larger than [_____] inches. The Contracting Officer shall be notified of any contaminated materials.

2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials shall include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials shall include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM shall be identified as cohesionless only when the fines are nonplastic.

2.1.4 Rock

Rock shall consist of boulders measuring 1/2 cubic yard or more and materials that cannot be removed without systematic drilling and blasting such as rock material in ledges, bedded deposits, unstratified masses and conglomerate deposits, and below ground concrete or masonry structures, exceeding 1/2 cubic yard in volume, except that pavements shall not be considered as rock.

2.1.5 Unyielding Material

****

NOTE: Stones should generally not exceed 75 mm (3 inches) in diameter. However, pipe manufacturer's criteria, if any, should be used.
****

Unyielding material shall consist of rock and gravelly soils with stones greater than [_____] inches in any dimension or as defined by the pipe manufacturer, whichever is smaller.

2.1.6 Unstable Material

Unstable material shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.

2.1.7 Select Granular Material

****
NOTE: Maximum size of aggregate should be not more than 8 mm per 100 mm (1 inch per foot) of pipe diameter, or 75 mm (3 inches) maximum. Refer to pipe manufacturer's criteria for more stringent requirements, if any, on aggregate size and gradation.
****

Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material passing a No. 200 mesh sieve and no less than 95 percent by weight passing the l inch sieve. The maximum allowable aggregate size shall be [_____] inches, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

2.1.8 Initial Backfill Material

Initial backfill shall consist of select granular material or satisfactory materials free from rocks [_____] inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, the initial backfill material shall be free of stones larger than [_____] inches in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

2.2 PLASTIC MARKING TAPE

Plastic marking tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be as specified in TABLE 1 and shall bear a continuous printed inscription describing the specific utility.

TABLE 1. Tape Color

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone, Telegraph, Television, Police, and Fire Communications
Blue:	Water Systems
Green:	Sewer Systems

PART 3 EXECUTION

3.1 EXCAVATION

****
NOTE: The details for disposal of excavated materials should be specified here. If dewatering is required due to ground water conditions, a paragraph on dewatering procedures and requirements should be developed.
****

Excavation shall be performed to the lines and grades indicated. Rock excavation shall include removal and disposition of material defined as rock in paragraph MATERIALS. Earth excavation shall include removal and disposal of material not classified as rock excavation. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench equal to 1/2 the depth of the excavation, but in no instance closer than 2 feet. Excavated material not required or not satisfactory for backfill shall be removed from the site [or shall be disposed of by [_____]]. Grading shall be done as may be necessary to prevent surface water from flowing into the excavation, and any water accumulating shall be removed to maintain the stability of the bottom and sides of the excavation. Unauthorized overexcavation shall be backfilled in accordance with paragraph BACKFILLING AND COMPACTION at no additional cost to the Government.

3.1.1 Trench Excavation Requirements

****
NOTE: The width of the trench below the top of the pipe will depend on the type of pipe used and soil conditions. The pipe manufacturer's installation manual should provide this information, and if so, it will be followed. In general, the width of trench will be 300 mm (12 inches) to 600 mm (24 inches), plus pipe O.D. for smaller pipe sizes, and 600 mm (24 inches) to 900 mm (36 inches) plus pipe O.D. for larger pipe sizes. Sloping walls below the top of the pipe are allowed for certain types of pipe in special ground conditions.
****

The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below the top of the pipe shall be sloped, or made vertical, and of such width as recommended in the manufacturer's installation manual. Where no manufacturer's installation manual is available, trench walls shall be made vertical. Trench walls more than [_____] feet high shall be shored, cut back to a stable slope, or provided with equivalent means of protection for employees who may be exposed to moving ground or cave in. Vertical trench walls more than [_____] feet high shall be shored. Trench walls which are cut back shall be excavated to at least the angle of repose of the soil. Special attention shall be given to slopes which may be adversely affected by weather or moisture content. The trench width below the top of pipe shall not exceed 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter and shall not exceed 36 inches plus pipe outside diameter for sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, redesign, stronger pipe, or special installation procedures shall be utilized by the Contractor. The cost of redesign, stronger pipe, or special installation procedures shall be borne by the Contractor without any additional cost to the Government.

3.1.1.1 Bottom Preparation

****

NOTE: Stones 75 mm (3 inches) or greater should be removed. However, pipe manufacturer's criteria, if any, should be used.

****

The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of [_____] inches or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

3.1.1.2 Removal of Unyielding Material

****

NOTE: Minimum of 100 mm (4 inches) should be removed to produce a suitable cushion for the pipe.

****

Where [overdepth is not indicated and] unyielding material is encountered in the bottom of the trench, such material shall be removed [_____] inches below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

3.1.1.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Government.

3.1.1.4 Excavation for Appurtenances

Excavation for manholes, catch-basins, inlets, or similar structures shall be [sufficient to leave at least 12 inches clear between the outer structure surfaces and the face of the excavation or support members] [of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown.] Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

3.1.1.5 Jacking, Boring, and Tunneling

****

NOTE: In situations where utility lines must be installed more than 5 to 7 meters (15 to 20 feet) below ground surface, through embankments, under minor roads or parking areas, or where surface conditions make it difficult or impractical to excavate open trenches, utility lines may be installed by jacking, boring, or tunneling as a contractor option. Where operational requirements preclude installation by trenching, the use of jacking, boring, or tunneling should be specified as mandatory alternatives. This requirement will normally exist where utilities must cross railroads, highways, primary access roads and airfield pavements. Pipe and conduit smaller than 900 mm (36 inches) in diameter will normally be installed in smooth steel pipe casing. Designing engineers must coordinate with installation facility engineers to identify and validate utility crossings where jacking, boring, or tunneling will be specified as mandatory.

****

Unless otherwise indicated, excavation shall be by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Contracting Officer, the pipe, cable, or duct can be safely and properly installed and backfill can be properly compacted in such sections.

3.1.2 Stockpiles

Stockpiles of satisfactory [and unsatisfactory] [and wasted materials] shall be placed and graded as specified. Stockpiles shall be kept in a neat and well drained condition, giving due consideration to drainage at all times. The ground surface at stockpile locations shall be cleared, grubbed, and sealed by rubber-tired equipment, excavated satisfactory and unsatisfactory materials shall be separately stockpiled. Stockpiles of satisfactory materials shall be protected from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources at no additional cost to the Government. [Locations of stockpiles of satisfactory materials shall be [as shown] [subject to prior approval of the Contracting Officer].]

3.2 BACKFILLING AND COMPACTION

Backfill material shall consist of satisfactory material, select granular material, or initial backfill material as required. Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to at least 95 percent maximum density for cohesionless soils and 90 percent maximum density for cohesive soils, unless otherwise specified.

3.2.1 Trench Backfill

****
NOTE: Most pressure tests require backfilling to at least 600 mm (2 feet) over the pipe with the joints and couplings left open for inspection.
****

Trenches shall be backfilled to the grade shown. [The trench shall be backfilled to [_____] feet above the top of pipe prior to performing the required pressure tests. The joints and couplings shall be left uncovered during the pressure test.] [The trench shall not be backfilled until all specified tests are performed.]

3.2.1.1 Replacement of Unyielding Material

Unyielding material removed from the bottom of the trench shall be replaced with select granular material or initial backfill material.

3.2.1.2 Replacement of Unstable Material

Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 6 inches loose thickness.

3.2.1.3 Bedding and Initial Backfill

****
NOTE: Bedding is provided to level out any irregularities in the foundation and to assure uniform support along the barrel of each pipe section. Bedding is also constructed to distribute the load bearing reaction, due to the weight of the backfill material, around the lower portion of the pipe. If the pipe or conduit is placed directly on a flat or shaped foundation, delete "bedding" from the title and from any reference in the paragraph. If bedding will be specified, determine type and thickness and show on the plans. Specify compaction to 95 percent maximum density for cohesionless soils, and 90 percent maximum density for cohesive soils.
****

[Bedding shall be of the type and thickness shown.] Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

3.2.1.4 Final Backfill

The remainder of the trench, except for special materials for roadways, railroads and airfields, shall be filled with satisfactory material. Backfill material shall be placed and compacted as follows:

a. Roadways, Railroads, and Airfields: Backfill shall be placed up to the elevation at which the requirements in Section 02300 EARTHWORK control. Water flooding or jetting methods of compaction will not be permitted.

b. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited in layers of a maximum of 12 inch loose thickness, and compacted to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. [Water flooding or jetting methods of compaction will be permitted for granular noncohesive backfill material. Water jetting shall not be allowed to penetrate the initial backfill.] [Compaction by water flooding or jetting will not be permitted.] This requirement shall also apply to all other areas not specifically designated above.

3.2.2 Backfill for Appurtenances

****
NOTE: The number of days the concrete is allowed to cure before backfilling the structure will depend on the type of mix and the concrete strength requirements specified. Three days would be considered as a minimum.
****

After the manhole, catchbasin, inlet, or similar structure has been constructed [and the concrete has been allowed to cure for [_____] days], backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.3 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

3.3.1 Gas Distribution

Trenches shall be excavated to a depth that will provide not less than 18 inches of cover in rock excavation and not less than 24 inches of cover in other excavation. Trenches shall be graded as specified for pipe-laying requirements in Section 02256 GAS DISTRIBUTION SYSTEM.

3.3.2 Water Lines

****

NOTE: Minimum depth of cover will be that required for frost penetration in the region and for safe operation of the utility. For fire protection yard mains, reference is made to NFPA 24 for recommended depth of cover.
****

Trenches shall be of a depth to provide a minimum cover of [_____] feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe. [For fire protection yard mains or piping, an additional [_____] inches of cover is required.]

3.3.3 Heat Distribution System

Initial backfill material shall be free of stones larger than 1/4 inch in any dimension.

3.3.4 Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 24 inches from the finished grade, unless otherwise indicated. [Special trenching requirements for direct-burial electrical cables and conduits are specified in Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.]

3.3.5 Plastic Marking Tape

****
NOTE: The use of plastic marking tape for identification purpose will be mandatory for buried hazardous utilities such as electrical conduit, gas line, high pressure nitrogen, high pressure water line, domestic sewage force mains, industrial waste force mains, and industrial sewers carrying hazardous, explosive or toxic waste. Tape should be used for all plastic or other nonferrous pipes and for ferrous pipes buried to depths such that the top of the pipe is more than 1 meter (3 feet) deep. Tape will be optional for nonhazardous utility lines such as domestic wastewater sewers (gravity) or storm drains.
****

Warning tapes shall be installed directly above the pipe, at a depth of [18] [_____] inches below finished grade unless otherwise shown.

3.4 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government.

3.4.1 Testing Facilities

Tests shall be performed by an approved commercial testing laboratory or may be tested by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved by the Contracting Officer.

3.4.2 Testing of Backfill Materials

Classification of backfill materials shall be determined in accordance with ASTM D 2487 and the moisture-density relations of soils shall be determined in accordance with ASTM D 1557. A minimum of one soil classification and one moisture-density relation test shall be performed on each different type of material used for bedding and backfill.

3.4.3 Field Density Tests

Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained. A minimum of one field density test per lift of backfill for every [_____] feet of installation shall be performed. One moisture density relationship shall be determined for every 1500 cubic yards of material used. Field in-place density shall be determined in accordance with [ASTM D 1556] [ASTM D 2167] [ASTM D 2922]. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted using the sand cone method as described in paragraph Calibration of the ASTM publication. ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the Contracting Officer. Copies of calibration curves, results of calibration tests, and field and laboratory density tests shall be furnished to the Contracting Officer. Trenches improperly compacted shall be reopened to the depth directed, then refilled and compacted to the density specified at no additional cost to the Government.

3.4.4 Displacement of Sewers

****

NOTE: The trench should be backfilled to at least 600 mm (2 feet).

****

After other required tests have been performed and the trench backfill compacted to [[_____] feet above the top of the pipe] [the finished grade surface], the pipe shall be inspected to determine whether significant displacement has occurred. This inspection shall be conducted in the presence of the Contracting Officer. Pipe sizes larger than 36 inches shall be entered and examined, while smaller diameter pipe shall be inspected by shining a light or laser between manholes or manhole locations, or by the use of television cameras passed through the pipe. If, in the judgement of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, the defects shall be remedied as directed at no additional cost to the Government.

-- End of Section --

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U.S. ARMY CORPS OF ENGINEERS **---------------------------**
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SECTION 02364

TERMITICIDE TREATMENT MEASURES FOR SUBTERRANEAN TERMITE CONTROL
06/98

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NOTE: This guide specification covers the requirements for termiticide treatment measures for subterranean termite control. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

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NOTE: Termite infestation exists throughout the United States and overseas areas with the exception of Alaska. Soil treatment will be specified for all types of construction where termites are likely to establish colonies and make concealed access to wood construction, including wood doors, windows, finish, and trim, or to wood-product, cloth, or cellulose storage in buildings. Soil treatment will also be required for structures constructed of or containing wood-preservative-treated items. However, soil treatment is not required for power plants, central-heating plants, water- or sewer-treatment

plants, incinerators, pump houses, and structures of similar nature which have neither wood in their construction nor wood or cellulose items stored within, and which have little chance of conversion to alternative uses.

Modification of this section, including materials, concentrations, or rates of application, considered necessary because of climatic conditions, porosity of soil to be treated, type of termite, or heavy infestation of termites, will be as recommended by the certified installation pest management coordinator. The modification will be in accordance with the guidance contained in the installation pest management program. Army Regulation 210-50, Housing Management, paragraph SPECIAL CONDITIONS, prohibits termiticide treatment through or under concrete slabs where HVAC ducts or vents are within or beneath the slab. Information is also available from state and local agriculture agencies and from the EPA National Pesticide Telephone Network at 1-800-858-7378.

When termites are known to be present on the project site, any crawl space on the ground level designed in a building needs to be designed for a concrete cover to be placed over the soil after treatment by a termiticide. Since the crawl space remains accessible to people and animals, it requires the concrete cover and signage.

For maximum termite protection, new structures should be designed and constructed using CCA- or borate-treated lumber, especially for foundation members. Untreated lumber in existing structures may be treated using rods of CCA or borate salts which can be inserted into non-treated wood and dissolved with water for absorption by the wood.

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1.1   SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

Termiticides; [_____].

Manufacturer's label and Material Safety Data Sheet (MSDS) for termiticides proposed for use.

SD-07 Schedules

Equipment; [_____].

A listing of equipment to be used.

SD-08 Statements

Foundation Exterior; [_____].

Written verification that other site work will not disturb the treatment.

Utilities and Vents; [_____].

Written verification that utilities, vents have been located.

Crawl and Plenum Air Spaces; [_____].

Written verification that crawl spaces and plenum air spaces have been located.

Soil Moisture; [_____].

Soil moisture test result.

Verification of Measurement; [_____].

Written verification that the volume of termiticide used meets the application rate.

SD-09 Reports

Equipment Calibration and Tank Calibration; [_____].

Certification of calibration tests conducted on the equipment used in the termiticide application

SD-13 Certificates

Qualifications; [_____].

Qualifications and state license number of the termiticide applicator.

SD-14 Samples

Termiticides; [_____].

Termiticide samples obtained during application, upon request.

SD-18 Record

Termiticide Application Plan; [_____].

Termiticide application plan with proposed sequence of treatment work with dates and times. The termiticide trade name, EPA registration number, chemical composition, formulation, concentration of original and diluted material, application rate of active ingredients, method of application, area/volume treated, amount applied; and the name and state license number of the state certified applicator shall be included.

1.2 QUALIFICATIONS

The Contractor's principal business shall be pest control. The Contractor shall be licensed and the termiticide applicators certified in the state where the work is to be performed. Termiticide applicators shall also be certified in the U.S. Environmental Protection Agency (EPA) pesticide applicator category which includes structural pest control.

1.3 SAFETY REQUIREMENTS

The Contractor shall formulate, treat, and dispose of termiticides and their containers in accordance with label directions. Use the clothing and personal protective equipment specified on the labeling for use during all phases of the application.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Termiticide material shall be delivered to the site in the original unopened containers bearing legible labels indicating the EPA registration number and manufacturer's registered uses. All other materials to be used on site for the purpose of termite control shall be delivered in new or otherwise good condition as supplied by the manufacturer or formulator.

1.4.2 Storage

Materials shall be stored in designated areas and in accordance with manufacturer's labels. Termiticides and related materials shall be kept under lock and key when unattended.

1.4.3 Handling

Termiticides shall be handled in accordance with manufacturer's labels. Manufacturer's warnings and precautions shall be observed. Materials shall be handled preventing contamination by dirt, water, and organic material. Protect termiticides from sunlight as recommended by the manufacturer.

1.5 INSPECTION

Termiticides shall be inspected upon arrival at the job site for conformity to type and quality in accordance with paragraph TERMITICIDE. Each label shall bear evidence of registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended. Other materials shall be inspected for conformance with specified requirements. Unacceptable materials shall be removed from the job site.

1.6 WARRANTY

****

NOTE: Use 5 years in temperate regions and 3 years in tropical and subtropical regions. Warranty period and the Contractor's responsibilities during the warranty period may be modified to be consistent with prevailing state or local practices.

****

The Contractor shall provide a [3] [5] [_____] -year written warranty against infestations or reinfestations by subterranean termites of the buildings or building additions constructed under this contract. Warranty shall include annual inspections of the buildings or building additions.

PART 2 PRODUCTS

2.1 TERMITICIDES

Termiticides shall be currently registered by the EPA. Termiticide shall be selected for maximum effectiveness and duration after application. The selected termiticide shall be suitable for the soil and climatic conditions at the project site.

PART 3 EXECUTION

3.1 TECHNICAL REPRESENTATIVE

The certified installation pest management coordinator shall be the technical representative, and shall be present at all meetings concerning treatment measures for subterranean termites. They may be present during treatment application.

3.2 SITE PREPARATION

Site preparation shall be in accordance with Sections 02230 CLEARING AND GRUBBING, 02300 EARTHWORK, 02315 EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS, 02921 SEEDING, 02922 SODDING, 02923 SPRIGGING, and 02930 EXTERIOR PLANTING. Work related to final grades, landscape plantings, foundations, or any other alterations to finished construction which might alter the condition of treated soils, shall be coordinated with this specification.

3.2.1 Ground Preparation

Food sources shall be eliminated by removing debris from clearing and grubbing and post construction wood scraps such as ground stakes, form boards, and scrap lumber from the site, before termiticide application begins.

3.2.2 Verification

Before work starts, the Contractor shall verify that final grades are as indicated and smooth grading has been completed in accordance with Section 02300 EARTHWORK. Soil particles shall be finely graded with particles no larger than 1 inch and compacted to eliminate soil movement to the greatest degree.

3.2.3 Foundation Exterior

The Contractor shall provide written verification that final grading and landscape planting operations will not disturb treatment of the soil on the exterior sides of foundation walls, grade beams, and similar structures.

3.2.4 Utilities and Vents

The Contractor shall provide written verification that the location and identity of HVAC ducts and vents, water and sewer lines, and plumbing have been accomplished prior to the termiticide application.

3.2.5 Crawl and Plenum Air Spaces

The Contractor shall provide written verification that the location and identity of crawl and plenum air spaces have been accomplished prior to the termiticide application.

3.3 SITE CONDITIONS

The following conditions shall determine the time of application.

3.3.1 Soil Moisture

Soils to be treated shall be tested immediately before application. Soil moisture content shall be tested to a minimum depth of 3 inches. The soil moisture shall be as recommended by the termiticide manufacturer. The termiticide will not be applied when soil moisture exceeds manufacturer's recommendations because termiticides do not adhere to the soil particles in saturated soils.

3.3.2 Runoff and Wind Drift

Termiticide shall not be applied during or immediately following heavy rains. Applications shall not be performed when conditions may cause runoff or create an environmental hazard. Applications shall not be performed when average wind speed exceeds 10 miles per hour. The termiticide shall not be allowed to enter water systems, aquifers, or endanger humans or animals.

3.3.2.1 Vapor Barriers and Waterproof Membranes

Termiticide shall be applied prior to placement of a vapor barrier or waterproof membrane.

3.3.2.2 Utilities and Vents

Prior to application, HVAC ducts and vents located in treatment area shall be turned off and blocked to protect people and animals from termiticide.

3.3.3 Placement of Concrete

Concrete covering treated soils shall be placed as soon as the termiticide has reached maximum penetration into the soil. Time for maximum penetration shall be as recommended by the manufacturer.

3.4 TERMITICIDE TREATMENT

3.4.1 Equipment Calibration and Tank Measurement

Immediately prior to commencement of termiticide application, calibration tests shall be conducted on the application equipment to be used and the application tank shall be measured to determine the volume and contents. These tests shall confirm that the application equipment is operating within the manufacturer's specifications and will meet the specified requirements. The Contractor shall provide written certification of the equipment calibration test results within 1 week of testing.

3.4.2 Mixing and Application

Formulating, mixing, and application shall be performed in the presence of the Contracting Officer or the technical representative. A closed system is recommended as it prevents the termiticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying termiticides shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately.

3.4.3 Treatment Method

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NOTE: Application shall be as a surface spray and/or by rodding and trenching.

****

For areas to be treated, the Contractor shall establish complete and unbroken vertical and/or horizontal soil poison barriers between the soil and all portions of the intended structure which may allow termite access to wood and wood related products. Application shall not be made to areas which serve as crawl spaces or for use as a plenum air space.

3.4.3.1 Surface Application

Surface application shall be used for establishing horizontal barriers. Surface applicants shall be applied as a coarse spray and provide uniform distribution over the soil surface. Termiticide shall penetrate a minimum of 1 inch into the soil, or as recommended by the manufacturer.

3.4.3.2 Rodding and Trenching

Rodding and trenching shall be used for establishing vertical soil barriers. Trenching shall be to the depth of the foundation footing. Width of trench shall be as recommended by the manufacturer, or as indicated. Rodding or other approved method may be implemented for saturating the base of the trench with termiticide. Immediately after termiticide has reached maximum penetration as recommended by the manufacturer, backfilling of the trench shall commence. Backfilling shall be in 6 inch rises or layers. Each rise shall be treated with termiticide.

3.4.4 Sampling

The Contracting Officer may draw from stocks at the job site, at any time and without prior notice, samples of the termiticides used to determine if the amount of active ingredient specified on the label is being applied.

3.5 VERIFICATION OF MEASUREMENT

Once termiticide application has been completed, tank contents shall be measured to determine the remaining volume. The total volume measurement of used contents for the application shall equal the established application rate for the project site conditions. The Contractor shall provide written verification of the measurements.

3.6 CLEAN UP, DISPOSAL, AND PROTECTION

Once application has been completed, the Contractor shall proceed with clean up and protection of the site without delay.

3.6.1 Clean Up

The site shall be cleaned of all material associated with the treatment measures, according to label instructions, and as indicated. Excess and waste material shall be removed and disposed off site.

3.6.2 Disposal of Termiticide

The Contractor shall dispose of residual termiticides and containers off Government property, and in accordance with label instructions and EPA criteria.

3.6.3 Protection of Treated Area

Immediately after the application, the area shall be protected from other use by erecting barricades and providing signage as required or directed. Signage shall be in accordance with Section 10430 EXTERIOR SIGNAGE. Signage shall be placed inside the entrances to crawl spaces and shall identify the space as treated with termiticide and not safe for children and animals.

3.7 CONDITIONS FOR SATISFACTORY TREATMENT

3.7.1 Equipment Calibrations and Measurements

Where results from the equipment calibration and tank measurements tests are unsatisfactory, re-treatment will be required.

3.7.2 Testing

Should an analysis, performed by a third party, indicate that the samples of the applied termiticide contain less than the amount of active ingredient specified on the label, and/or if soils are treated to a depth less than specified or approved, re-treatment will be required.

3.7.3 Disturbance of Treated Soils

Soil and fill material disturbed after treatment shall be re-treated before placement of slabs or other covering structures.

3.7.4 Termites Found Within the Warranty Period

If live subterranean termite infestation or termite damage is discovered during the warranty period, the Contractor shall re-treat the site.

3.8 RE-TREATMENT

Where re-treatment is required, the Contractor shall:

a. Re-treat the soil and/or perform other treatment as necessary for prevention or elimination of subterranean termite infestation.

b. Repair damage caused by termite infestation.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02466 (December 1997)**
U.S. ARMY CORPS OF ENGINEERS **--------------------------**
Superseding
CEGS-02383 (April 1989)

GUIDE SPECIFICATION FOR CONSTRUCTION
Includes Text Adjustment Change (Section References) (November 1998)
Latest change indicated by CHG tags

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SECTION 02466

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12/97

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Superseding
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Includes Text Adjustment Change (Section References) (November 1998)
Latest change indicated by CHG tags

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SECTION 02466

DRILLED FOUNDATION CAISSONS (PIERS)
12/97

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NOTE: This guide specification covers the requirements for drilled foundation caissons (piers) including reinforcing and cast-in-place concrete. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 615/A 615M	(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616/A 616M	(1996) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617/A 617M	(1996a) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM D 1143	(1981; R 1994) Piles Under Static Axial Compressive Load
ASTM D 1586	(1984; R 1992) Penetration Test and Split-Barrel Sampling of Soils

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1996) Structural Welding Code - Steel
AWS D1.4	(1992) Structural Welding Code - Reinforcing Steel

1.2 BASIS OF BID AND UNIT PRICES

****
NOTE: This paragraph anticipates bids on a lump sum price for an entire project including caisson work with directed changes being in accordance with the CONTRACT CLAUSES or in accordance with unit prices as defined in paragraph "Unit Prices." Delete "in accordance with the CONTRACT CLAUSES" or paragraphs "Tests" and "Unit Prices" for lump sum projects.
****

1.2.1 Bids

The bid shall be based on the number and total length of caissons, established by top and bottom elevations and diameters, as indicated and specified. Adjustment of the contract will be made [in accordance with the CONTRACT CLAUSES], should the total length of caissons installed and approved be greater or less than the total length shown. The Contractor will not be allowed payment for rejected caissons or for those not conforming to specifications.

1.2.2 Tests

1.2.2.1 Load Test

Contract shall include [_____] load tests rated at [_____] ton per caisson. The Contracting Officer reserves the right to increase or decrease the number of load tests. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Caisson Load Test" or "Omitted Caisson Load Test".

1.2.2.2 Penetration Test

Contract shall include [_____] penetration tests. The Contracting Officer reserves the right to increase or decrease the number of penetration tests. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Penetration Test" or "Omitted Penetration Test".

1.2.2.3 Proof Test Hole

Contract shall include [_____] proof test holes. The Contracting Officer reserves the right to increase or decrease the number of proof test holes. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Proof Test Hole" or "Omitted Proof Test Hole".

1.2.3 Unit Prices

1.2.3.1 Additional Caisson Lengths

Additional caisson lengths will be paid for at the contract unit price for "Additional Caisson Length" for each diameter of caisson installed as approved.

1.2.3.2 Omitted Caisson Lengths

The contract price will be reduced by the amount bid for "Omitted Caisson Length" for each diameter of caisson omitted as directed.

1.2.3.3 Casings Permanently Left in Place

Steel casings permanently left in place due to contract conditions:

a. Total pounds of steel beyond casings indicated will be paid for at the contract unit price per pound for "Additional Steel Casing."

b. Omitted Casing Steel: The contract price will be reduced by the amount bid for "Omitted Casing Steel" omitted as directed.

1.2.3.4 Reinforcing Steel for Additional Caisson

Reinforcing steel for additional caisson lengths will be paid for at the contract unit price for "Additional Caisson Reinforcing Steel" installed as approved.

1.2.3.5 Reinforcing Steel for Caissons Omitted

The contract price will be reduced by the amount bid for "Omitted Caisson Reinforcing Steel" omitted as directed.

1.2.3.6 Removal of Rock

Removal of rock within the limit of caissons will be paid for at the contract unit price for "Removal of Rock" per linear foot, for each diameter of caisson installed. Rock excavation is defined as any hard dense material that cannot be removed with caisson drilling equipment having the specified capacity and could only be removed by hand, air tools, blasting, or other specialized methods.

1.2.3.7 Removal of Obstructions Other Than Rock

Removal of obstructions other than rock within the limits of the caissons which cannot be removed using standard caisson drilling equipment with the specified capacity will be paid for at the contract unit price per linear foot for "Removal of Obstructions" for each diameter of caisson installed.

1.3 BASIS OF PAYMENT

****

NOTE: Where the basis for bidding is based entirely on unit price, paragraph BASIS OF BID AND UNIT PRICES should be deleted and the following paragraph substituted.

****

1.3.1 Unit Price

The Contracting Officer shall have the right to increase or decrease the linear footage of drilled foundation caissons to be furnished and installed by changing the foundation caisson elevations, by requiring the installation of additional caissons, or omission of caissons from the requirements shown and specified. Whether or not such changes are made, the Contractor shall be paid at the contract unit price per linear foot (including test caissons) multiplied by the total linear feet of acceptable caissons actually installed provided, however, that in the event the Contracting Officer requires an increase or decrease in the linear footage of caissons furnished and installed, the contract unit price will be adjusted in accordance with the CONTRACT CLAUSES.

1.3.2 Full Compensation

Payment in accordance with the above paragraph Unit Price shall constitute full compensation for furnishing, delivering, handling, and/or installing (as applicable) all material, labor and equipment necessary to meet contract requirements applicable to the foundation caissons. The Contractor will not be allowed payment for rejected caissons.

1.3.3 Load Tests

The contract includes [_____] [_____] -ton caisson load tests. The Contracting Officer reserves the right to increase or decrease the number of load tests. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Caisson Load Test" or "Omitted Caisson Load Test."

1.3.4 Penetration Tests

Contract shall include [_____] penetration tests. The Contracting Officer reserves the right to increase or decrease the number of penetration tests. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Penetration Test" or "Omitted Penetration Test."

1.3.5 Proof Test Holes

Contract shall include [_____] proof test holes. The Contracting Officer reserves the right to increase or decrease the number of proof test holes. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Proof Test Hole" or "Omitted Proof Test Hole."

1.4   SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

NOTE: Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Drilled Foundation Caissons; [_____].

A certified copy of the survey. Lines and levels shall be established and caisson centerline locations staked and maintained by a registered surveyor or engineer provided by the Contractor.

SD-08 Statements

Qualifications; [_____].

Qualifications of the foundation system Contractor shall show that he has been engaged in the successful installation of drilled foundation caissons for at least [_____] years.

SD-09 Reports

Load Tests; [_____]. Penetration Tests; [_____].

Test Results.

SD-18 Records

Drilled Foundation Caissons; [_____].

Detailed records in an approved form, for each caisson, showing shaft and bell diameters, depths of test holes, top and bottom elevations, bearing strata description, casing description, water conditions, concrete strength, concrete volume, rock elevations, dates of excavation and concrete placement, and other pertinent information. Upon completion of caisson work, the Contractor shall provide a record of centerline locations based on the survey of the registered surveyor or engineer provided by the Contractor. In addition, corrective measures shall be similarly recorded. A complete tabulation of all records pertaining to approved caissons shall be delivered to the Contracting Officer.

1.5   QUALIFICATIONS

1.5.1   Specialty Subcontractor

****
NOTE: Select applicable paragraph for agency requirements. Basically, from 3 to 5 years should be required for second paragraph.
****

The work shall be performed by a specialty subcontractor, specializing in the specified foundation system and having experience installing the specified foundation system under similar subsurface conditions.

1.5.2   Welding

Detail and field welding shall be in accordance with AWS D1.1. Qualification of welding procedures, welders, and welding operators shall be in accordance with AWS D1.1, Section 5. Records of test results of welding procedures not prequalified and copies of records for each qualified welding operator, containing records on positions of welding and types of electrode qualifications, shall be kept by the Contractor and be available for examination by the Contracting Officer.

1.6   PROJECT/SITE CONDITIONS

1.6.1   Subsurface Data

****
NOTE: Include location of available samples.
****

Subsurface soil data logs are shown on the drawings. The subsurface investigation report and samples of materials, as taken from subsurface investigations, are available for examination at [_____].

1.6.2   Caisson Drilling Equipment

****
NOTE: Caisson drilling equipment criteria should be evaluated and specified for contract site conditions. Reference: Drilled Pier Foundations - Woodward, Gardner, Greer - McGraw-Hill Book Co. Requirements should be included for determination of minimum equipment standards.
****

Caisson drilling equipment shall have the minimum torque capacity and downward force capacity for the contract site conditions.

1.7   SEQUENCE OF WORK

****
NOTE: Sequence of work criteria should be modified for agency requirements.
****

1.7.1   Caisson Excavation

Excavation of caissons or groups of caissons shall be performed so that reinforcing steel and concrete placement is a continuous operation performed the same day that the excavation is completed. Excavations shall not be left open overnight.

1.7.2 Acceptance

Concrete shall be placed within 3 hours after approval of the completed excavation.

1.8 SUPERVISION, INSPECTION, AND SAFETY

1.8.1 Contractor Supervision

The Contractor shall provide for the supervision of all phases of drilled pier construction. Supervision shall be the Contractor's responsibility as outlined in Quality Control provisions of the SPECIAL CONTRACT REQUIREMENTS. Each drilled pier excavation shall be checked by the Contractor for its depth, water removal, cleanup, workmanship, and for all tolerance requirements before any concrete is placed.

1.8.2 Government Inspection

The Contracting Officer will inspect each drilled pier excavation. Concrete shall not be placed until the excavation has been approved by the Contracting Officer. The Contractor shall furnish the Contracting Officer all necessary equipment required for proper inspection of drilled pier excavations.

1.8.3 Safety Precautions for Workmen and Inspectors

1.8.3.1 Life Line

Each person entering a drilled pier excavation shall be provided with a life line rigged so that the person can be immediately hoisted out of the excavation in an emergency. The life line shall be suitable for instant rescue, securely fastened to a shoulder harness, and separated from any line used to remove excavated materials. No person shall be lowered into a drilled pier excavation prior to casing the shaft through the overburden.

1.8.3.2 Ventilation

Each drilled pier excavation shall be provided with a ventilating device of sufficient capacity to assure a safe and healthy atmosphere before workmen and inspectors are permitted to enter the drilled pier excavation and during all work periods.

PART 2 PRODUCTS

2.1 CONCRETE WORK

****

NOTE: Include information for concrete work. Correlate with Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE for pertinent information or include concrete specifications in this section.

****

Concrete work shall be in accordance with requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE, as modified herein:

2.1.1 Coarse Aggregate

Maximum size of coarse aggregate shall be [_____].

2.1.2 Reinforcing Steel

Reinforcing steel shall conform to [ASTM A 615/A 615M] [ASTM A 616/A 616M] [ASTM A 617/A 617M] Grade [_____]. Steel shall be welded into cages in accordance with AWS D1.4 and inserted securely in the caissons, in position and alignment, as shown, [prior to concrete placement] [prior to the concrete reaching an elevation of [_____] feet below the bottom elevation of the reinforcement].

2.1.3 Strength

Concrete strength shall be [_____] psi at 28 days. Slump shall be from [_____] to [_____] inches.

PART 3 EXECUTION

3.1 PREPARATION

****
NOTE: Caissons selected for contract shall be based on analysis of subsurface investigation and design requirements. Complete installation information.
****

a. Caissons shall be excavated to established depths and dimensions shown. Bottoms of caissons shall be cleaned of loose or soft material and leveled. Excavated material shall be disposed of in accordance with Section 02300 EARTHWORK.

b. In drilling caissons, the surrounding soil and the earth walls shall be adequately and securely protected against cave-ins, displacement of the surrounding earth, and retention of ground water, by means of temporary steel casings. Casings shall have outside diameters not less than indicated shaft sizes, shall be a minimum of 1/4 inch thick, and shall not be removed if the structural integrity of the caisson will be impaired, as determined by the Contracting Officer. Temporary steel casings shall be withdrawn, as the concrete is being placed, maintaining sufficient head of concrete within the casing to prevent extraneous material from falling in from the sides and mixing with the concrete. Casings may be jerked upward a maximum of 4 inches to break the bottom seal, but thereafter shall be removed with a smooth, continuous motion.

c. The inside of steel casings shall be thoroughly cleaned and oiled before reuse.

d. The temporary casing shall be in place from the caisson top to the ground surface until the concrete has set if the elevation of the top of the caisson is below the adjacent ground surface.

e. The outside diameter of permanent casing shall be the same as the nominal shaft diameter. Wall thickness of permanent casings shall be a minimum of [_____]inches.

f. Water that flows into the excavations shall be continuously removed and all water shall be removed from the excavation bottom, to the extent possible, prior to concrete placement. The maximum permissible depth of water will be 2 inches. In the event of a severe water condition that makes it impossible or impractical to dewater the excavation, concrete shall be placed using underwater tremie after water movement has stabilized.

g. The bottoms of excavations indicated to be "belled" shall be enlarged to diameters and shapes shown. Bells shall be excavated or drilled in a similar manner to that used for shafts.

h. The excavations for caissons indicated to be ["ribbed"] [_____] shall be of the dimensions and shapes indicated.

i. Each caisson excavation will be inspected and approved by the Contracting Officer prior to placing concrete. A record of all inspections, with related construction changes, shall be kept by the Contractor. The Contractor shall provide support personnel for inspection and testing procedures.

3.2 INSTALLATION

a. Concrete shall be continuously placed by methods that ensure against segregation and dislodging of excavation sidewalls, and shall completely fill the shaft. Concrete shall be placed by pumping or drop chutes in dry holes and by tremie or pumping in wet holes. The discharge shall be kept a minimum of 3 feet below the fresh concrete surface during placement. Drilling of caissons or driving of casings shall not be within 20 feet of concrete placed within the last 3 days.

b. Concrete shall be brought to a true level surface inside the shaft and a full width cross key formed, or dowels installed, should it become necessary to interrupt placing concrete in any caisson. Prior to placing additional concrete, surfaces shall be cleaned of laitance and slush with one-to-one portland cement grout. The grout shall have a water-cement ratio not exceeding that of the concrete.

c. Concrete in dry batter caissons shall be placed with a drop chute extending within 3 feet of the concrete surface in the excavation.

d. Concrete shall be vibrated for [full height of caisson] [upper [_____] feet of caisson]. Belled caissons shall be vibrated full height.

3.3 TOLERANCES

****
NOTE: Tolerances should be correlated with design criteria and types of caisson.
****

a. Any caisson out of center or plumb beyond the tolerance specified shall be corrected as necessary to comply with the tolerances and the Contractor shall bear any cost of correction.

b. Cross sections of shafts and bells shall not be less than design dimensions.

c. Caissons shall be installed with top location deviating a maximum of [3][_____] inches from centerline locations.

d. Vertical caissons shall be installed plumb within a maximum of 1-1/2 inches for the first 10 feet and within l/2 inch for each 10 feet of additional depth.

e. Batter caissons shall be installed a maximum of [2] [_____] percent of length from specified inclination.

3.4 PENETRATION TESTS

****

NOTE: Penetration tests should be included when bearing investigations are determined to be a contract requirement.

****

Penetration Tests shall conform to the following:

a. After excavation, penetration tests in the bottoms of the caissons, in [locations indicated] [[_____] caissons], to determine bearing conditions, shall be made in accordance with ASTM D 1586.

b. The tests shall be made after caisson bottoms have been cleaned out. Minimum blow count shall be [_____] per foot.[Penetration tests shall be taken to a depth of [_____] feetbelow the bearing elevation. The Contractor shall obtain and retain jar samples, as directed by the Contracting Officer.]

c. If the minimum blow count is not obtained, the shaft shall be drilled an additional [_____] feet and the penetration test rerun.

d. Reports shall be submitted to the Contracting Officer in accordance with ASTM D 1586.

The Contracting Officer will approve tests and authorize subsequent concrete placement or initiate redesign procedures.

3.5 PROOF TEST HOLE REQUIREMENTS

****

NOTE: Omit proof test holes if rock bearing is not anticipated or nature of rock and extent of principal testing makes further testing unnecessary.

****

Rock Soundness test shall conform to the following:

a. After excavation, the rock below each caisson bearing level shall be proof tested for soundness by percussion or rotary core drilling one hole in each caisson in locations indicated.

b. Holes shall be of 2 inch diameter and drilled with a uniform downward pressure to a depth below the bearing level equal to the design caisson shaft diameter but to a minimum of 4 feet.

c. Penetration time for successive 6 inchincrements shall be recorded, noting conditions encountered.

The Contracting Officer will approve test holes and authorize subsequent concrete placement or initiate redesign procedures.

3.6 LOAD TESTS

****
NOTE: Specify load tests to confirm caisson design. Indicate number, size, and location of test caissons and sequence.
****

3.6.1 General Requirements

a. Caisson load tests shall be performed in locations indicated.

b. Tests shall be performed under supervision of a registered engineer provided by the Contractor and in the presence of the Contracting Officer. Test procedure shall be approved by the Contracting Officer prior to commencement of work.

c. Load shall be applied in concentric manner with magnitude of load accurately determined and controlled.

d. Top of caisson shall be laterally supported during entire load test.

e. [Caisson shall be loaded to [150] [200] percent of design load, but shall not exceed ultimate concrete strength at time of loading. Load shall be applied in increments of [_____]. Full test load shall be maintained for a period of [24] [_____] hours and settlement readings made at not less than [1/2] [_____] -hour intervals.] [Load test shall be performed in accordance with ASTM D 1143, except the maximum load shall not exceed [_____] [200] percent of the design load.]

f. [_____] copies of the test report shall be submitted directly to the Contracting Officer.

g. Tested installations will be considered of adequate design and construction if:

(1) No apparent distress occurs in caisson construction.

(2) Residual settlement, after test load is removed, does not exceed [_____] inches.

(3) Twice the design load does not cause a gross settlement of more than [_____] inches.

3.6.2 Replacements

Test caissons found inadequate because of improper instrumentation, testing, or construction procedures shall be replaced and retested, at no additional cost to the Government.

3.7 PROTECTION

Protection shall be provided around top of the excavation to prevent debris from being dislodged into the excavation and concrete.

-- End of Section --

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SECTION 02510

WATER DISTRIBUTION SYSTEM
04/98

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NOTE: This guide specification covers the requirements for water supply, distribution, and service lines and connections to building service at a point approximately 1.5 m (5 feet) outside buildings and structures to which service is required. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for service lines, distribution lines, fire hydrants, hose houses. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN RAILWAY ENGINEERING & MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Manual	(1999) 1998-1999 Manual for Railway Engineering (Fixed Properties) 4 Vol.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded, and Seamless
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 88M	(1996) Seamless Copper Water Tube (Metric)
ASTM C 76	(1998) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 76M	(1997) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM D 1599	(1988; R 1995) Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
ASTM D 1784	(1996) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(1996b) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(1996b) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(1996a) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1997) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(1996a) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2657	(1997) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D 2774	(1994) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 2996	(1995) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 2997	(1995) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe
ASTM D 3139	(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3839	(1994a) Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
ASTM F 477	(1996a) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 1483	(1998) Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B36.10M	(1996) Welded and Seamless Wrought Steel Pipe

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

AWWA C105	(1993) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C111	(1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	(1996) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C153	(1994; Errata Nov 1996) Ductile-Iron Compact Fittings, 3 In. Through 24 In. (76 mm through 610 mm) and 54 In. through 64 In. (1,400 mm through 1,600 mm) for Water Service
AWWA C200	(1997) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(1997) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C205	(1995) Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. (100 mm) and Larger - Shop Applied
AWWA C207	(1994) Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
AWWA C208	(1996) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C300	(1997) Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids
AWWA C301	(1992) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids
AWWA C303	(1995) Concrete Pressure Pipe, Bar-Wrapped, Steel Cylinder Type
AWWA C500	(1993; C500a) Metal-Sealed Gate Valves for Water Supply Service
AWWA C502	(1994; C502a) Dry-Barrel Fire Hydrants
AWWA C503	(1997) Wet-Barrel Fire Hydrants

AWWA C504	(1994) Rubber-Seated Butterfly Valves
AWWA C509	(1994) Resilient-Seated Gate Valves for Water Supply Service
AWWA C600	(1993) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	(1997) Grooved and Shouldered Joints
AWWA C651	(1992) Disinfecting Water Mains
AWWA C700	(1995) Cold-Water Meters - Displacement Type, Bronze Main Case
AWWA C701	(1988) Cold-Water Meters - Turbine Type, for Customer Service
AWWA C702	(1992) Cold-Water Meters - Compound Type
AWWA C703	(1996) Cold-Water Meters - Fire Service Type
AWWA C704	(1992) Propeller-Type Meters Waterworks Applications
AWWA C706	(1996) Direct-Reading, Remote-Registration Systems for Cold-Water Meters
AWWA C707	(1982; R 1992) Encoder-Type Remote-Registration Systems for Cold-Water Meters
AWWA C800	(1989) Underground Service Line Valves and Fittings
AWWA C900	(1997; C900a Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution
AWWA C901	(1996) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. Through 3 In., for Water Service
AWWA C905	(1997) Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 In. Through 36 In.
AWWA C950	(1995) Fiberglass Pressure Pipe
AWWA M23	(1980) Manual: PVC Pipe - Design and Installation

ASBESTOS CEMENT PIPE PRODUCERS ASSOCIATION (ACPPA)

ACPPA Work Practices	(1988) Recommended Work Practices for A/C Pipe

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

DIPRA-Restraint Design	(1997) Thrust Restraint Design for Ductile Iron Pipe

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24	(1995) Installation of Private Fire Service Mains and Their Appurtenances
NFPA 49	(1994) Hazardous Chemicals Data
NFPA 325-1	(1994) Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids
NFPA 704	(1996) Identification of the Fire Hazards of Materials for Emergency Response
NFPA 1961	(1997) Fire Hose

NSF INTERNATIONAL (NSF)

NSF 14	(1998) Plastics Piping Components and Related Materials
NSF 61	(1998) Drinking Water System Components - Health Effects (Sections 1-9)

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 21	(1991) White or Colored Silicone Alkyd Paint
SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)

1.2 PIPING

****

NOTE: All pipe materials specified will be retained except under conditions where they would not be suitable; see TM 5-813-5/AFM 88-10, Vol. 5. Where it is determined that a pipe material would be altogether unsuitable, every mention of the unsuitable material and referenced publications that pertain only to the unsuitable material will be deleted. If a material would be suitable in a part of the system and unsuitable in other parts, the locations where the material may and may not be used will be shown on the contract drawings and stated in the contract specifications. A study of the conditions will be made to determine the suitability

of the materials. If doubt remains after the study, because of exceptional conditions, a report should be submitted to HQUSACE (CEMP-ET).

Ferrous metal piping should not be buried in the ground in the vicinity of switchyards or hydroelectric powerhouses. Experience has shown that rapid failure of the pipe occurs from galvanic corrosion due to the proximity of large copper ground mats.

The following definitions are established for use with this guide specification.

Water Supply Line: A pipeline from the source of supply to the treatment works or to the distribution system. For lines connected to the distribution system, only that portion which would not be subject to future tapping will be designated as water supply line. When a water supply line is connected so that it is subject to the same pressures as the distribution system, the working pressure will be not less than that required for the distribution system.

Water Distribution Line: A pipeline which is part of the distribution system. The distribution system comprises the network of piping throughout building areas and other areas of water use or fire demand, and includes hydrants, valves, and other appurtenances used to supply water for domestic and fire fighting purposes.

Water Service Line: Pipeline connecting building piping to water distribution lines.
****

This section covers water [supply] [distribution] [service] lines, and connections to building service at a point approximately 5 feet outside buildings and structures to which service is required. The Contractor shall have a copy of the manufacturer's recommendations for each material or procedure to be utilized available at the construction site at all times.

1.2.1 Service Lines

Piping for water service lines less than 3 inchesin diameter shall be galvanized steel, polyvinyl chloride (PVC) plastic, Oriented PVC plastic polyethylene, or copper tubing, unless otherwise shown or specified. Piping for water service lines 3 inchesand larger shall be ductile iron, polyvinyl chloride (PVC) plastic, filament-wound or centrifugally cast reinforced thermosetting resin, reinforced plastic mortar pressure pipe or steel, unless otherwise shown or specified.

1.2.2 Distribution Lines 80 mm (3 Inches) or Larger

Piping for water distribution lines 3 inches or larger shall be ductile iron, polyvinyl chloride (PVC) through 36 inch nominal diameter plastic, Oriented PVC plastic filament-wound or centrifugally cast reinforced thermosetting resin, reinforced plastic mortar pressure pipe, or reinforced concrete, unless otherwise shown or specified.

1.2.3 Supply Lines 80 mm (3 Inches) or Larger

Piping for water supply lines 3 inches or larger shall be ductile iron, polyvinyl chloride (PVC) plastic, through 36 inch nominal diameter, Oriented PVC plastic filament-wound reinforced or centrifugally cast reinforced thermosetting resin, reinforced plastic mortar pressure pipe, steel, or reinforced concrete, unless otherwise shown or specified.

1.2.4 Sprinkler Supply Lines

Piping for water lines supplying sprinkler systems for building fire protection shall conform to NFPA 24 from the point of connection with the water distribution system to the building 5 foot line.

1.2.5 Potable Water Lines

****
NOTE: Incorporate this paragraph only if it is a requirement of the state where the project will be constructed.
****

Piping and components of potable water systems which come in contact with the potable water shall conform to NSF 61.

1.2.6 Plastic Piping System

****
NOTE: Incorporate this paragraph only if it is a requirement of the state where the project will be constructed.
****

Plastic piping system components (PVC, polyethylene, thermosetting resin and reinforced plastic mortar pressure) intended for transportation of potable water shall comply with NSF 14 and be legibly marked with their symbol.

1.2.7 Excavation, Trenching, and Backfilling

Excavation, trenching, and backfilling shall be in accordance with the applicable provisions of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, except as modified herein.

1.3 UNIT PRICES

****
NOTE: When it is determined that lump sum contract is advisable, this paragraph will be deleted.
****

Measurement and payment will be based on completed work performed in accordance with the drawings, specifications, and the contract payment schedules. Payment will not be made under this section for excavation, trenching, or backfilling. Payment for such work will be made under Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

1.3.1 Measurement

The length of water lines to be paid for will be determined by measuring along the centerlines of the various sizes of pipe furnished and installed. Pipe will be measured from center of fitting to center of fitting, from center of water distribution line to end of service connection, and from center of water distribution line to center of hydrant. No deduction will be made for the space occupied by valves or fittings.

1.3.2 Payment

Payment will be made for water lines at the contract unit price per linear foot for the various types and sizes of water lines, and will be full compensation for all pipes, joints, specials, and fittings, complete in place. Payment for fire hydrants, gate valves, valve boxes, and standard valve manholes will be made at the respective contract unit price each for such items complete in place. Payment will include the furnishing of all testing, plant, labor, and material and incidentals necessary to complete the work, as specified and as shown.

1.4 MANUFACTURER'S REPRESENTATIVE

The Contractor shall have a manufacturer's field representative present at the jobsite during the installation and testing of PE, RTRP, and/or RPMP pipe to provide technical assistance and to verify that the materials are being installed in accordance with the manufacturer's prescribed procedures. When the representative feels that the Contractor is installing and testing the PE, RTRP, and/or RPMP pipe in a satisfactory manner, certification shall be written to note which individuals employed by the Contractor are capable of properly installing the pipe. The field representative shall advise the Contractor of unsatisfactory conditions immediately when they occur. Such conditions include improper diameter of pipe ends, damaged interior liner, poorly prepared joints, improper curing of joints, moving pipe before joints are cured, bending pipe to follow abrupt changes in trench contours, leaving pipe ends open in trench overnight, not properly drying joints after rain storms, exceeding effective adhesive life, sharp objects in trench bed, backfill that could damage pipe, improper procedure for concrete encasement of pipe, omission of thrust blocks at changes in direction or any other condition which could have an adverse effect on the satisfactory completion and operation of the piping system.

1.5 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for

information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

Installation; [_____].

The manufacturer's recommendations for each material or procedure to be utilized.

SD-08 Statements

Waste Water Disposal Method; [_____].

The method proposed for disposal of waste water from hydrostatic tests and disinfection, prior to performing hydrostatic tests.

Satisfactory Installation; [_____].

A statement signed by the principal officer of the contracting firm stating that the installation is satisfactory and in accordance with the contract drawings and specifications, and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance.

SD-09 Reports

Bacteriological Disinfection; [_____].

Test results from commercial laboratory verifying disinfection.

SD-13 Certificates

Manufacturer's Representative; [_____].

The name and qualifications of the manufacturer's representative and written certification from the manufacturer that the representative is technically qualified in all phases of PE, RTRP, and/or RPMP pipe laying and jointing and experienced to supervise the work and train the Contractor's field installers, prior to commencing installation.

Installation; [_____].

A statement signed by the manufacturer's field representative certifying that the Contractor's personnel are capable of properly installing the pipe on the project.

Meters; [_____].

Manufacturer's certificate stating that each meter furnished has been tested for accuracy of registration and compliance with the accuracy and capacity requirements of the appropriate AWWA standard.

1.6 HANDLING

Pipe and accessories shall be handled to ensure delivery to the trench in sound, undamaged condition, including no injury to the pipe coating or lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor in a satisfactory manner, at no additional cost to the Government. No other pipe or material shall be placed inside a pipe or fitting after the coating has been applied. Pipe shall be carried into position and not dragged. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place.

1.6.1 Coated and Wrapped Steel Pipe

Coated and wrapped steel pipe shall be handled in conformance with AWWA C203.

1.6.2 Polyethylene (PE) Pipe Fittings and Accessories

PE pipe, fittings, and accessories shall be handled in conformance with AWWA C901.

1.6.3 Miscellaneous Plastic Pipe and Fittings

Polyvinyl Chloride (PVC), Reinforced Thermosetting Resin Pipe (RTRP), and Reinforced Plastic Mortar Pressure (RPMP) pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendations. Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325-1.

PART 2 PRODUCTS

2.1 PIPE

****

NOTE: Class 150 pipe will normally be specified for water distribution systems except where local conditions require a higher class. Class 150 pipe is furnished with wall thickness suitable for laying with a standard design depth of cover, using a flat bottom trench without blocks and with compacted backfill. For other conditions the class or pressure and loading will be specified accordingly. See TM 5-813-5 for additional criteria and requirements regarding pipe.

****

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 Reinforced and Prestressed Concrete Pipe

****

NOTE: AWWA Standards do not include reinforced and

prestressed concrete pipe sizes less than 250 mm (10 inches) in diameter. Applicable size ranges for publications referenced in this paragraph are as follows:

Range of Diameter Size

mm (inches)	**Publication**
250-1050 (10-42)	**AWWA C303 (Reinforced)**
600-3600 (24-144)	**AWWA C300 (Reinforced)**
400-3600 (16-144)	**AWWA C301 (Prestressed)**

In certain localities 150 mm and 200 mm (6 and 8 inch) prestressed concrete pipe is available. When such pipe is available, it should conform to AWWA C303 with the following exceptions:

Nominal inside diameter of pipe, mm		**150**	**200**
	(inches)	**(6)**	**(8)**
Nominal lining thickness, mm		**6**	**6**
	(inch)	**(1/4)**	**(1/4)**
Nominal coating thickness, mm		**25**	**25**
	(inch)	**(1)**	**(1)**

Class 150

Total steel area per meter, square mm (per foot, square inch)		**1990 (0.94)**	**1990 (0.94)**
Minimum cylinder thickness, mm	**(gauge)**	**1.519 16**	**1.519 16**

****

Steel cylinder reinforced concrete pipe shall conform to AWWA C300, AWWA C301, or AWWA C303 and shall be designed to withstand a working pressure of not less than 150 psi unless otherwise shown or specified.

2.1.2 Plastic Pipe

2.1.2.1 PE Plastic Pipe

Pipe, tubing, and heat-fusion fittings shall conform to AWWA C901.

2.1.2.2 PVC Plastic Pipe

****

NOTE: Design stresses for pipe will meet the requirements of Appendix A of AWWA C900. SDR pipe manufactured and rated in accordance with ASTM D 2241, or any other referenced specification, will be rated and specified for working pressures in conformance with AWWA C900, Appendix A. PVC 1120 pipe, couplings and fittings will not be installed in a system subjecting the pipe to cyclic hoop stress in excess of 11.0 MPa (1600 psi). This rating is based on 23 degrees C (73.4 degrees F) or lower operating temperatures. Derating for higher operating temperature will be in accordance with AWWA C900, TABLE A1, Appendix A. The designer must evaluate the surge pressures that the system, in which pipe is to be installed, is capable of generating to assure the above requirement is met. Excessive surge pressures should be prevented by eliminating the causative condition or providing automatic surge-pressure relief. Plastic pipe shall not be used when it will be subject to temperature in excess of 37.8 degrees C (100 degrees F) in installed usage or exposed to a source of heat from adjacent lines or equipment.

****

Pipe, couplings and fittings shall be manufactured of material conforming to ASTM D 1784, Class 12454B.

a. Pipe Less Than 4 inch Diameter:

(1) Screw-Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 80, with joints meeting requirements of 150 psi working pressure, 200 psi hydrostatic test pressure, unless otherwise shown or specified. Pipe couplings when used, shall be tested as required by ASTM D 2464.

(2) Elastomeric-Gasket Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 40, with joints meeting the requirements of 150 psi working pressure, 200 psi hydrostatic test pressure, unless otherwise shown or specified, or it may be pipe conforming to requirements of ASTM D 2241, elastomeric joint, with the following applications:

SDR	Maximum Working Pressure psi	Minimum Hydrostatic Pressure psi
26	100	133
21	120	160
17	150	200
13.5	200	266

(3) Solvent Cement Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the

requirements of 150 psi working pressure and 200 psi hydrostatic test pressure.

b. Pipe 4 through 12 inch Diameter: Pipe, couplings and fittings shall conform to AWWA C900, Class 150, CIOD pipe dimensions, elastomeric-gasket joint, unless otherwise shown or specified.

c. Pipe 14 through 36 inch Diameter: Pipe shall conform to AWWA C905 unless otherwise shown or specified.

2.1.2.3 Oriented Polyvinyl Chloride (PVCO) Plastic Pipe

Pipe, couplings, and fittings shall be manufactured of material conforming to ASTM D 1784, Class 1245B. Pipe shall conform to AWWA C900, Class 150, and to ASTM F 1483 and shall have an outside diameter equal to cast iron outside diameter.

2.1.3 Reinforced Plastic Mortar Pressure (RPMP) Pipe

AWWA C950.

2.1.4 Reinforced Thermosetting Resin Pipe (RTRP)

Pipe shall have a quick-burst strength greater than or equal to four times the normal working pressure of the pipe. The quick-burst strength test shall conform to the requirements of ASTM D 1599.

2.1.4.1 RTRP-I

RTRP-I shall conform to ASTM D 2996, except pipe shall have an outside diameter equal to cast iron outside diameter or standard weight steel pipe. The pipe shall be suitable for a normal working pressure of 150 psi at 73 degrees F. The inner surface of the pipe shall have a smooth uniform continuous resin-rich surface liner conforming to ASTM D 2996.

2.1.4.2 RTRP-II

RTRP-II shall conform to ASTM D 2997. Pipe shall have an outside diameter equal to standard weight steel pipe.

2.1.5 Ductile-Iron Pipe

****

NOTE: Cement-mortar linings with twice the standard thickness may be specified for ductile-iron pipe conveying unusually aggressive waters. Consideration will be given to the service life of the pipe and the potential for changes in treatment methods.

Polyethylene encasement will apply where soil conditions warrant, in accordance with Appendix A of AWWA C105.

****

Ductile-iron pipe shall conform to AWWA C151, working pressure not less than 150 psi, unless otherwise shown or specified. Pipe shall be cement-mortar lined in accordance with AWWA C104. Linings shall be standard. When installed underground, pipe shall be encased with [_____] mil thick polyethylene in accordance with AWWA C105. Flanged ductile iron pipe with threaded flanges shall be in accordance with AWWA C115.

2.1.6 Steel Pipe

2.1.6.1 Pipe 80 mm (3 Inches) and Larger, Not Galvanized

****

NOTE: Use of nongalvanized steel pipe is restricted to water supply and service lines only where future tapping is not anticipated; use for sizes 80 mm (3 inches) in diameter and larger. Pipe sizes and minimum acceptable thickness required will be inserted in the blanks.

For high sulfate soils or waters, cement will be specified to conform to ASTM C 150, Portland Cement, Type II. When reactive aggregates are used, cement will be specified to conform to ASTM C 150, Portland Cement, low alkali. When specified, ASTM C 150, Portland Cement, will be added to paragraph REFERENCES.

****

Steel pipe, not galvanized, shall conform to AWWA C200 with dimensional requirements as given in ASME B36.10M for pipe 6 inches in diameter and larger, and ASTM A 53 for smaller sizes. Pipe shall be welded or seamless with plain or shouldered and grooved ends in accordance with AWWA C606 for use with mechanical couplings or bell-and-spigot ends with rubber gaskets. Bell-and-spigot ends for sizes less than 6 inches diameter shall be as required by AWWA C200. The minimum wall thickness of the various sizes of pipe shall be as follows:

Pipe Sizes	Thickness
[_____]	[_____]

2.1.6.2 Galvanized Steel Pipe

Galvanized steel pipe shall conform to ASTM A 53, standard weight.

2.1.6.3 Protective Materials for Steel Pipe

****

NOTE: Protective materials for galvanized pipe less than 80 mm (3 inches) in diameter will be required only where the pipe is within the zone of influence of adjacent buried cathodic protection systems.

****

Protective materials for steel pipe, except as otherwise specified, shall be mechanically applied in a factory or plant especially equipped for the purpose. The materials shall, unless otherwise indicated on the drawings, consist of [one of the following] [the following] for the indicated pipe material and size:

a. Pipe and fittings less than 3 inches in diameter shall be thoroughly cleaned of foreign material by wire brushing and solvent cleaning, and then given 1 coat of coal-tar primer and 2 coats of coal-tar enamel conforming to AWWA C203; threaded ends of pipe and fittings shall be adequately protected prior to coating.

b. Pipe 3 Inches or Larger, Not Galvanized:

(1) Cement-mortar coating and lining shall conform to and shall be applied in conformance with AWWA C205. Cement-mortar coating and linings shall not be used for pipe less than 4 inches in diameter.

(2) Coal-tar enamel lining, coating and wrapping shall conform to AWWA C203 for materials, method of application, tests and handling. Non-asbestos material shall be used for the outerwrap.

(3) Cement-mortar lining, in lieu of coal-tar enamel lining, may be used with coal-tar enamel coating and wrapping. Cement-mortar lining shall conform to and shall be applied in conformance with AWWA C205.

2.1.7 Copper Tubing

****

NOTE: Use copper tubing for water service lines. Joints are limited to pipe sizes less than 65 mm (2-1/2 inches) in diameter.

****

Copper tubing shall conform to ASTM B 88, Type K, annealed.

2.2 FITTINGS AND SPECIALS

2.2.1 Reinforced Concrete Pipe System

Fittings and specials required for closures, curves, bends, branches and connections to valves, pipe, or structures shall be approved by the Contracting Officer and conform to the details furnished by the manufacturer and to AWWA C300, AWWA C301, or AWWA C303, as applicable.

2.2.2 PVC Pipe System

a. For pipe less than 4 inch diameter, fittings for threaded pipe shall conform to requirements of ASTM D 2464, threaded to conform to the requirements of ASME B1.20.1 for use with Schedule 80 pipe and fittings; fittings for solvent cement jointing shall conform to ASTM D 2466 or ASTM D 2467; and fittings for elastomeric-gasket joint pipe shall be iron conforming to AWWA C110 or AWWA C111. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104.

b. For pipe 4 inch diameter and larger, fittings and specials shall be iron, bell end in accordance with AWWA C110, 150 psi pressure rating unless otherwise shown or specified, except that profile of bell may have special dimensions as required by the pipe manufacturer; or fittings and specials may be of the same material as the pipe with elastomeric gaskets, all in conformance with AWWA C900. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Fittings shall be bell and spigot or plain end pipe, or as applicable. Ductile iron compact fittings shall be in accordance with AWWA C153.

2.2.3 RTRP and RPMP Pipe

Fittings and specials shall be compatible with the pipe supplied. Filament wound or molded fittings up to 6 inches shall conform to AWWA C950. Iron fittings shall be cement-mortar lined in accordance with AWWA C104 and shall conform to AWWA C110 and AWWA C111. Fittings shall be suitable for working and testing pressures specified for the pipe.

2.2.4 Ductile-Iron Pipe System

****

NOTE: The use of cast gray iron fittings and specials with ductile-iron pipe is generally acceptable. However, when required by unusually severe loading conditions, ductile-iron fittings and specials conforming to AWWA C110 may be specified.

****

Fittings and specials shall be suitable for 150 psi pressure rating, unless otherwise specified. Fittings and specials for mechanical joint pipe shall conform to AWWA C110. Fittings and specials for use with push-on joint pipe shall conform to AWWA C110 and AWWA C111. Fittings and specials for grooved and shouldered end pipe shall conform to AWWA C606. Fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Ductile iron compact fittings shall conform to AWWA C153.

2.2.5 Steel Pipe System

2.2.5.1 Not Galvanized Steel Pipe

Fittings and specials shall be made of the same material as the pipe. Specials and fittings may be made of standard steel tube turns or segmentally welded sections, with ends to accommodate the type of couplings or joints specified for the pipe. Dimensions of steel pipe fittings shall be in accordance with AWWA C208. The thickness and pressure rating of pipe fittings and specials shall be not less than the thickness specified and the pressure rating calculated for the pipe with which they are used. Protective materials for fittings and specials shall be as specified for the pipe. Specials and fittings that cannot be mechanically lined, coated, and wrapped shall be lined, coated, and wrapped by hand, using the same material used for the pipe with the same number of applications of each material, smoothly applied.

2.2.5.2 Galvanized Steel Piping

Steel fittings shall be galvanized. Screwed fittings shall conform to ASME B16.3. Flanged fittings shall conform to AWWA C207.

2.2.5.3 Dielectric Fittings

Dielectric fittings shall be installed between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure.

2.2.6 Copper Tubing System

****
NOTE: The maximum nominal pipe size of fittings and specials in ASME B16.26 is 50 mm (2 inches).
****

Fittings and specials shall be flared and conform to ASME B16.26.

2.3 JOINTS

2.3.1 Gaskets for Reinforced Concrete Pipe

Rubber-gasket joints shall be of the type using a bell-and-spigot joint design of steel. The gaskets shall conform to AWWA C300, AWWA C301, or AWWA C303, as applicable.

2.3.2 Plastic Pipe Jointing

2.3.2.1 PE Pipe

Joints for pipe fittings and couplings shall be strong tight joints as specified for PE in Paragraph INSTALLATION. Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendation, and as approved by the Contracting Officer.

2.3.2.2 PVC Pipe

Joints, fittings, and couplings shall be as specified for PVC pipe. Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer.

2.3.2.3 PVCO Pipe

Joints shall conform to ASTM D 3139. Elastomeric gaskets shall conform to ASTM F 477.

2.3.3 RPMP Pipe

Joints shall be mechanical or bell and spigot type with elastomeric gasket.

2.3.4 RTRP Pipe

2.3.4.1 RTRP-I, Grade 1 and 2

Joints shall be bell and spigot with elastomeric gasket, mechanical coupling with elastomeric gasket, threaded and bonded coupling, or tapered bell and spigot with compatible adhesive. All RTRP-I materials shall be products of a single manufacturer.

2.3.4.2 RTRP-II, Grade 1 and 2

Joints shall be the bell and spigot type with elastomeric gasket, bell and spigot with adhesive, butt-jointed with adhesive bonded reinforced overlay, mechanical, flanged, threaded or commercially available proprietary joints, provided they are capable of conveying water at the pressure and temperature of the pipe.

2.3.5 Ductile-Iron Pipe Jointing

a. Mechanical joints shall be of the stuffing box type and shall conform to AWWA C111.

b. Push-on joints shall conform to AWWA C111.

c. Rubber gaskets and lubricants shall conform to the applicable requirements of AWWA C111.

2.3.6 Steel Pipe Jointing

2.3.6.1 Steel Pipe, Not Galvanized

a. Mechanical couplings shall be as specified.

b. Bell-and-spigot joints for use with rubber gaskets shall conform to AWWA C200, as appropriate for the type of pipe. Rubber gaskets shall conform to applicable requirements of AWWA C200.

c. Flanges shall conform to AWWA C207, and shall be used only in above ground installation or where shown on the drawings, or when approved.

2.3.6.2 Mechanical Couplings

Mechanical couplings for steel pipe shall be the sleeve type, or when approved, the split-sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movements caused by expansion, contraction, slight setting or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Couplings shall be of strength not less than the adjoining pipeline.

2.3.7 Bonded Joints

****

NOTE: Bonded joints will be used to maintain electrical continuity in metallic pipeline where cathodic protection is provided during construction or where it is anticipated that cathodic protection will be provided in the future.

****

[Where indicated] [For all ferrous pipe], a metallic bond shall be provided at each joint, including joints made with flexible couplings, caulking, or rubber gaskets, of ferrous metallic piping to effect continuous conductivity. The bond wire shall be Size 1/0 copper conductor suitable for direct burial shaped to stand clear of the joint. The bond shall be of the thermal weld type.

2.3.8 Isolation Joints

Isolation joints shall be installed between nonthreaded ferrous and nonferrous metallic pipe, fittings and valves. Isolation joints shall consist of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

a. Sleeve-type couplings shall be used for joining plain end pipe sections. The two couplings shall consist of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.

b. Split-sleeve type couplings may be used in aboveground installations when approved in special situations and shall consist of gaskets and a housing in two or more sections with the necessary bolts and nuts.

2.3.9 Copper Tubing Jointing

Joints shall be compression-pattern flared and shall be made with the specified fittings.

2.4 VALVES

2.4.1 Check Valves

Check valves shall be designed for a minimum working pressure of 150 psi or as indicated. Valves shall have a clear waterway equal to the full nominal diameter of the valve. Valves shall open to permit flow when inlet pressure is greater than the discharge pressure, and shall close tightly to prevent return flow when discharge pressure exceeds inlet pressure. The size of the valve, working pressure, manufacturer's name, initials, or trademark shall be cast on the body of each valve. Valves 2 inches and larger shall be [outside lever and spring] [outside lever and weight] [_____] type.

a. Valves 2 inches and smaller shall be all bronze designed for screwed fittings, and shall conform to MSS SP-80, Class 150, Types 3 and 4 as suitable for the application.

b. Valves larger than 2 inches shall be iron body, bronze mounted, shall have flanged ends, and shall be the non-slam type. Flanges shall be the Class 125 type conforming to ASME B16.1.

2.4.2 Gate Valves

****
Note: Delete reference to AWWA C500 if resilient-seated gate valves are required.
****

Gate valves shall be designed for a working pressure of not less than 150 psi. Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening.

a. Valves smaller than 3 inches shall be all bronze and shall conform to MSS SP-80, Type 1, Class 150.

b. Valves 3 inches and larger shall be iron body, bronze mounted, and shall conform to AWWA C500. Flanges shall not be buried. An approved pit shall be provided for all flanged connections.

c. Resilient-Seated Gate Valves: For valves 3 to 12 inches in size, resilient-seated gate valves shall conform to AWWA C509.

2.4.3 Rubber-Seated Butterfly Valves

Rubber-seated butterfly valves shall conform to the performance requirements of AWWA C504. Wafer type valves conforming to the performance requirements of AWWA C504 in all respects, but not meeting laying length requirements will be acceptable if supplied and installed with a spacer providing the specified laying length. All tests required by AWWA C504 shall be met. Flanged-end valves shall be installed in an approved pit and provided with a union or sleeve-type coupling in the pit to permit removal. Mechanical-end valves 3 through 10 inches in diameter may be direct burial if provided with a suitable valve box, means for manual operation, and an adjacent pipe joint to facilitate valve removal. Valve operators shall restrict closing to a rate requiring approximately 60 seconds, from fully open to fully closed.

2.4.4 Pressure Reducing Valves

Pressure reducing valves shall maintain a constant downstream pressure regardless of fluctuations in demand. Valves shall be suitable for [_____] psi operating pressure on the inlet side, with outlet pressure set for [_____] psi. The valves shall be of the hydraulically-operated, pilot controlled, globe or angle type, and may be actuated either by diaphragm or piston. The pilot control shall be the diaphragm-operated, adjustable, spring-loaded type, designed to permit flow when controlling pressure exceeds the spring setting. Ends shall be [threaded] [flanged]. Valve bodies shall be bronze, cast iron or cast steel with bronze trim. Valve stem shall be stainless steel. Valve discs and diaphragms shall be synthetic rubber. Valve seats shall be bronze. Pilot controls shall be bronze with stainless steel working parts.

2.4.5 Vacuum and Air Relief Valves

Vacuum and air relief valves shall be of the size shown and shall be of a type that will release air and prevent the formation of a vacuum. The valves shall automatically release air when the lines are being filled with water and shall admit air into the line when water is being withdrawn in excess of the inflow. Valves shall be iron body with bronze trim and stainless steel float.

2.4.6 Indicator Post for Valves

Each valve shown on the drawings with the designation "P.I.V." shall be equipped with indicator post conforming to the requirements of NFPA 24. Operation shall be by a wrench which shall be attached to each post.

2.5 VALVE BOXES

Valve boxes shall be cast iron or concrete, except that concrete boxes may be installed only in locations not subjected to vehicular traffic. Cast-iron boxes shall be extension type with slide-type adjustment and with flared base. The minimum thickness of metal shall be 3/16 inch. Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment. The word "WATER" shall be cast in the cover. The box length shall adapt, without full extension, to the depth of cover required over the pipe at the valve location.

2.6 VALVE PITS

Valve pits shall be constructed at locations indicated or as required above and in accordance with the details shown. Concrete shall have compressive strength of 3000 psi in accordance with Section 03300CAST-IN-PLACE STRUCTURAL CONCRETE.

2.7 FIRE HYDRANTS

****

NOTE: Wet barrel hydrants will be allowed only in warm climates where freezing is not a problem. Where existing hydrants do not have American National standard fire-hose coupling threads, adapters with male threads conforming to local practice will be specified for the new hydrants. If adapters are to be permanently fixed to the hydrant, caps will be specified. If adapters are required for pumper outlet only, the appropriate deletions of words and brackets will be made.

****

Hydrants shall be [dry-barrel type conforming to AWWA C502 with valve opening at least 5 inches in diameter and designed so that the flange at the main valve seat can be removed with the main valve seat apparatus remaining intact, closed and reasonably tight against leakage and with a breakable valve rod coupling and breakable flange connections located no more than 8 inches above the ground grade] [wet-barrel type conforming to AWWA C503, with either an automatic breakoff check valve or an auxiliary gate valve on hydrant branch]. Hydrants shall have a 6 inch bell connection, two 2-1/2 inch hose connections and one 4-1/2 inch pumper connection. Outlets shall have American National Standard fire-hose coupling threads. Working parts shall be bronze. Design, material, and workmanship shall be equal to the latest stock pattern ordinarily produced by the manufacturer. Hydrants shall be painted with 1 coat of red iron oxide, zinc oxide primer conforming to SSPC Paint 25 and 2 finish coats of silicone alkyd paint conforming to SSPC Paint 21, [of the installation's standard colors or as directed by the Contracting Officer] [color in accordance with NFPA recommendations]. Suitable bronze adapter for [the 4-1/2 inch] [each] outlet, with caps, shall be furnished.

2.8 FIRE-HYDRANT HOSE HOUSES

****

NOTE: The hydrant-hose house equipment listed is standard for areas such as family housing where mobile fire department response within approximately 15 minutes is unlikely. In other types of installations where lack of prompt fire department response necessitates fully equipped hydrant-hose houses for use by station personnel, the type and amount of equipment needed for individual hose houses will be adjusted depending on the needs of the immediate area. In salt water areas or other locations where there is a corrosive atmosphere,

metal-hose houses will not be specified.
****

Hose houses conforming to the requirements of NFPA 24 shall be furnished at each fire hydrant indicated on the drawings to have a fire-hydrant hose house. The following equipment, in addition to that listed in NFPA 24, paragraph 5-6.1, shall be furnished with each hose house:

a. 200 feet of 2-1/2 inch, woven jacketed, rubber lined hose conforming to NFPA 1961 with a minimum service test pressure of 300 psi.

b. 100 feet of 1-1/2 inch, woven jacketed, rubber lined hose conforming to NFPA 1961 with a minimum service test pressure of 300 psi.

c. One gated 2-1/2 by 1-1/2 by 1-1/2 inch wye.

d. One playpipe for 2-1/2 inch hose with 1 inch shutoff nozzle tip.

e. One playpipe for 1-1/2 inch hose with 1/2 inch shutoff nozzle or combination nozzle.

f. Two adapter fittings, 2-1/2 to 1-1/2 inch.

g. Two spanners for 1-1/2 inch hose.

2.9 MISCELLANEOUS ITEMS

2.9.1 Service Clamps

Service clamps shall have a pressure rating not less than that of the pipe to be connected and shall be either the single or double flattened strap type. Clamps shall have a galvanized malleable-iron body with cadmium plated straps and nuts. Clamps shall have a rubber gasket cemented to the body.

2.9.2 Corporation Stops

Corporation stops shall have standard corporation stop thread conforming to AWWA C800 on the inlet end, with flanged joints, compression pattern flared tube couplings, or wiped joints for connections to goosenecks.

2.9.3 Goosenecks

Copper tubing for gooseneck connections shall conform to the applicable requirements of ASTM B 88, Type K, annealed. Length of cable requirement connections shall be in accordance with standard practice.

2.9.4 Service Stops

Service stops shall be water-works inverted-ground-key type, oval or round flow way, tee handle, without drain. Pipe connections shall be suitable for the type of service pipe used. All parts shall be of bronze with female iron-pipe-size connections or compression-pattern flared tube couplings, and shall be designed for a hydrostatic test pressure not less than 200 psi.

2.9.5 Tapping Sleeves

Tapping sleeves of the sizes indicated for connection to existing main shall be the cast gray, ductile, or malleable iron, split-sleeve type with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Construction shall be suitable for a maximum working pressure of [150] [_____] psi. Bolts shall have square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets shall be as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, it shall consist of an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pretorqued to 50 foot-pound.

2.9.6 Service Boxes

Service boxes shall be cast iron or concrete and shall be extension service boxes of the length required for the depth of the line, with either screw or slide-type adjustment. The boxes shall have housings of sufficient size to completely cover the service stop or valve and shall be complete with identifying covers.

2.9.7 Disinfection

Chlorinating materials shall conform to the following:

Chlorine, Liquid: AWWA B301.

Hypochlorite, Calcium and Sodium: AWWA B300.

2.9.8 Meters

****

NOTE: Refer to the applicable AWWA standard and delete inappropriate wording. Delete types of meters not required. Where highly aggressive water is encountered, the manufacturers should be consulted for recommendations concerning materials of construction.

****

Meters shall be the type and size shown on the drawings or specified. Meters of each of the various types furnished and installed shall be supplied by one manufacturer.

2.9.8.1 Displacement Type

Displacement type meters shall conform to AWWA C700. Registers shall be straight-reading and shall read in [U.S. gallons] [cubic feet]. Meters in sizes 1/2 through 1 inch [shall] [shall not] be frost-protection design. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be [a direct reading remote register designed in accordance with AWWA C706] [or] [an encoder type remote register designed in accordance with AWWA C707]. Meters shall comply with the accuracy and capacity requirements of AWWA C700.

2.9.8.2 Turbine Type

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NOTE: Turbine type main-line meters require a strainer.
****

Turbine type meters shall conform to AWWA C701 [Class I] [Class II]. The main casing shall be [bronze] [cast iron protected by corrosion resistant coating] with stainless steel external fasteners. Registers shall be straight-reading type, shall be [permanently sealed] [open] and shall read in [U.S. gallons] [cubic feet]. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be [a direct reading remote register designed in accordance with AWWA C706] [or] [an encoder type remote register designed in accordance with AWWA C707]. Meters shall comply with the accuracy and capacity requirements of AWWA C701.

2.9.8.3 Compound Type

Compound type meters shall conform to AWWA C702 and [shall] [shall not] be furnished with strainers. The main casing shall be [bronze] [cast iron protected by corrosion resistant coating] with stainless steel external fasteners. The main casing shall be tapped for field testing purposes. Registers shall be straight-reading type, shall be [permanently sealed] [open] and shall read in [U.S. gallons] [cubic feet]. The meter [shall] [shall not] be equipped with a coordinating register. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be [a direct reading remote register designed in accordance with AWWA C706] [or] [an encoder type remote register designed in accordance with AWWA C707]. Meters shall comply with the accuracy and capacity requirements of AWWA C702.

2.9.8.4 Fire Service Type

Fire service type meters shall be [proportional type] [turbine type] conforming to AWWA C703 and [shall] [shall not] be furnished with strainers. The main casing shall be [bronze] [cast iron protected by corrosion resistant coating] with stainless steel external fasteners. Registers shall be straight-reading type, shall be [permanently sealed] [open] and shall read in [U.S. gallons] [cubic feet]. The meter [shall] [shall not] be equipped with a coordinating register. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be [a direct reading remote register designed in accordance with AWWA C706] [or] [an encoder type remote register designed in accordance with AWWA C707]. Meters shall comply with the accuracy and capacity requirements of AWWA C703. When turbine type main line meters are used, the meter shall be supplied with a separate check valve, as a unit.

2.9.8.5 Propeller Type

Propeller type meters shall conform to AWWA C704. Registers shall be straight-reading type, shall be [permanently sealed] [open] and shall read in [U.S. gallons] [cubic feet]. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be [a direct-reading remote register designed in accordance with AWWA C706] [or] [an encoder-type remote register designed in accordance with AWWA C707]. Meters shall comply with the accuracy and capacity requirements of AWWA C703.

2.9.9 Meter Boxes

Meter boxes shall be of cast iron, concrete, or plastic. The boxes shall be of sufficient size to completely enclose the meter and shutoff valve or service stop. Meter boxes set in paved areas subject to vehicular traffic shall be cast iron, or concrete with cast iron lid and cast iron meter reader lid. Boxes set in sidewalks, not subject to vehicular traffic, [shall use concrete covers with cast iron meter reader lids] [shall be concrete with cast iron lid and cast iron meter reader lid]. Plastic boxes and lids [shall] [shall not] be used in unpaved areas or grass areas not subject to vehicular traffic. Box height shall extend from invert of the meter to final grade at the meter location. The lid shall have the word "WATER" cast in it.

2.10 METER VAULTS

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Note: The designer shall provide construction details of meter vaults on the drawings.

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Large meters shall be installed in reinforced concrete vaults in accordance with the details shown on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Cutting of Pipe

Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the Contracting Officer, cutting shall be done with an approved type mechanical cutter. Wheel cutter shall be used when practicable. Copper tubing shall be cut square and all burrs shall be removed. Squeeze type mechanical cutters shall not be used for ductile iron.

3.1.2 Adjacent Facilities

****

NOTE: It will be the Contractor's responsibility to maintain the proper clearances between water lines and sewers. Where the water main is to be laid near the route of an existing sewer, force main, or inverted siphon, the in-place location of the sewer will be checked before laying the water main and, where necessary to provide minimum horizontal or vertical separation, will be shown on the contract drawings.

****

3.1.2.1 Sewer Lines

Where the location of the water pipe is not clearly defined in dimensions on the drawings, the water pipe shall not be laid closer horizontally than 10 feet from a sewer except where the bottom of the water pipe will be at least 12 inches above the top of the sewer pipe, in which case the water pipe shall not be laid closer horizontally than 6 feet from the sewer. Where water lines cross under gravity-flow sewer lines, the sewer pipe, for a distance of at least 10 feet each side of the crossing, shall be fully encased in concrete or shall be made of pressure pipe with no joint located within 3 feet horizontally of the crossing. Water lines shall in all cases cross above sewage force mains or inverted siphons and shall be not less than 2 feet above the sewer main. Joints in the sewer main, closer horizontally than 3 feet to the crossing, shall be encased in concrete.

3.1.2.2 Water Lines

Water lines shall not be laid in the same trench with sewer lines, gas lines, fuel lines, or electric wiring.

3.1.2.3 Copper Tubing Lines

Copper tubing shall not be installed in the same trench with ferrous piping materials.

3.1.2.4 Nonferrous Metallic Pipe

Where nonferrous metallic pipe, e.g. copper tubing, crosses any ferrous piping material, a minimum vertical separation of 12 inchesshall be maintained between pipes.

3.1.2.5 Casing Pipe

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Note: For casing pipe design , refer to AWWA Manual of Practice M-11 for design of steel pipe and to American Railway Engineering Association, Part 10, or Concrete Pipe Handbook for design of concrete casing pipe.

The first blank in the paragraph should have the name of the railway company having jurisdiction inserted where applicable.

****

Water pipe shall be encased in a sleeve of rigid conduit for the lengths shown. Sleeves under railroads shall be in accordance with [the [_____] railroad company requirements] [the criteria contained in AREMA Manual, Part 5]. Where sleeves are required, in all other cases, the pipe sleeve shall be [steel, manufactured in accordance with AWWA C200, ASTM A 36/A 36M, [_____], with a minimum wall thickness of [_____]] [reinforced concrete in accordance with and ASTM C 76, Class [V] [_____] as specified for storm drains in Section 02630 STORM-DRAINAGE SYSTEM]. A minimum clearance of at least 2 inches between the inner wall of the sleeve and the maximum outside diameter of the sleeved pipe and joints shall be provided. Sand bedding or suitable pipe support shall be provided for the water pipe through the sleeve. Sleeves of ferrous material shall be provided with corrosion protection as required in Section [13110 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [_____].

3.1.2.6 Structures

Where water pipe is required to be installed within 3 feet of existing structures, the water pipe shall be sleeved as required in Paragraph "Casing Pipe". The Contractor shall install the water pipe and sleeve ensuring that there will be no damage to the structures and no settlement or movement of foundations or footings.

3.1.3 Joint Deflection

3.1.3.1 Allowable for Reinforced Concrete Pipe

Maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets, shall be 5 degrees for reinforced concrete pipe unless a lesser amount is recommended by the manufacturer. Long radius curves in reinforced concrete pipe shall be formed by straight pipe in which spigot rings are placed on a bevel. Slight deflections may be made by straight pipe, provided that the maximum joint opening caused by such deflection does not exceed the maximum recommended by the pipe manufacturer. Short radius curves and closures shall be formed by shorter lengths of pipe, bevels, or fabricated specials specified.

3.1.3.2 Offset for Flexible Plastic Pipe

Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer and approved by the Contracting Officer, but shall not exceed 5 degrees.

3.1.3.3 Allowable for Ductile-Iron Pipe

The maximum allowable deflection shall be as given in AWWA C600. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.

3.1.3.4 Allowable for Steel Pipe

For pipe with bell-and-spigot rubber-gasket joints, maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets shall be 5 degrees unless a lesser amount is recommended by the manufacturer. Short-radius curves and closures shall be formed by short lengths of pipe or fabricated specials specified.

3.1.4 Placing and Laying

Pipe and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or other authorized equipment. Water-line materials shall not be dropped or dumped into the trench. Abrasion of the pipe coating shall be avoided. Except where necessary in making connections with other lines or as authorized by the Contracting Officer, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until joints are complete. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by and at the Contractor's expense in a satisfactory manner. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored, as shown.

3.1.4.1 Reinforced Concrete Pipe Installation

Reinforced concrete pipe shall be installed in accordance with recommendations of the pipe manufacturer. Before laying reinforced concrete pipe, the outside surface of the spigot and the inside surface of the bell shall be cleaned and an acceptable vegetable-compound lubricant applied to the inside surface of the bell and to the rubber gasket. Where prescribed by the pipe manufacturer, the gasket shall be placed in the groove on the end of the pipe before the pipe is placed in the trench. After the pipe has been forced together, the position of the rubber gasket shall be checked with a feeler gauge in accordance with the pipe manufacturer's recommendations. Tapping of reinforced concrete cylinder pipe shall be done in accordance with the manufacturer's approved recommendations. Where the manufacturer recommends that the taps be made by attaching the rubber-gasketed saddle to the outside of the pipe using U-bolts, the saddle shall be grouted in if necessary, the mortar coating shall be chipped away, even with the hole in the saddle plate. The exposed circumferential wires shall be removed and the cylinder and concrete core drilled out, and the steel saddle and U-bolts shall be protected by concrete encasement.

3.1.4.2 Plastic Pipe Installation

RTRP shall be installed in accordance with ASTM D 3839. RPMP shall be installed in accordance with the manufacturer's recommendations. PE Pipe shall be installed in accordance with ASTM D 2774. PVC pipe shall be installed in accordance with AWWA M23.

3.1.4.3 Piping Connections

Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions. When made under pressure, these connections shall be installed using standard methods as approved by the Contracting Officer. Connections to existing asbestos-cement pipe shall be made in accordance with ACPPA Work Practices.

3.1.4.4 Penetrations

Pipe passing through walls of valve pits and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and sleeves shall be filled with rich cement mortar. Annular space between pipe and sleeves shall be filled with mastic.

3.1.4.5 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

3.1.5 Jointing

3.1.5.1 Reinforced Concrete Pipe Requirements

The inside and outside annular spaces between abutting sections of concrete pipe shall be filled with rich cement mortar in accordance with the pipe manufacturer's recommendations. Excess mortar shall be removed from interior annular spaces, leaving a smooth and continuous surface between pipe sections. Exposed portions of steel joint rings shall be protected from corrosion by a metallic coating or by an approved nonmetallic coating. Rubber gaskets shall be handled, lubricated where necessary, and installed in accordance with the pipe manufacturer's recommendations.

3.1.5.2 PE Pipe Requirements

Jointing shall comply with ASTM D 2657, Technique I-Socket Fusion or Technique II-Butt Fusion.

3.1.5.3 PVC Plastic Pipe Requirements

a. Pipe less than 4 inch diameter: Threaded joints shall be made by wrapping the male threads with approved thread tape or applying an approved lubricant, then threading the joining members together. The joint shall be tightened using strap wrenches to prevent damage to the pipe and/or fitting. To avoid excessive torque, joints shall be tightened no more than one thread past hand-tight. Preformed rubber-ring gaskets for elastomeric-gasket joints shall be made in accordance with ASTM F 477 and as specified. Pipe ends for push-on joints shall be beveled to facilitate assembly and marked to indicate when the pipe is fully seated. The gasket shall be prelubricated to prevent displacement. The gasket and ring groove in the bell or coupling shall match. The manufacturer of the pipe or fitting shall supply the elastomeric gasket. Couplings shall be provided with stops or centering rings to assure that the coupling is centered on the joint. Solvent cement joints shall use sockets conforming to ASTM D 2467. The solvent cement used shall meet the requirements of ASTM D 2564; the joint assembly shall be made in accordance with ASTM D 2855 and the manufacturer's specific recommendations.

b. Pipe 4 through 12 inch diameter: Joints shall be elastomeric gasket as specified in AWWA C900. Jointing procedure shall be as specified for pipe less than 4 inch diameter with configuration using elastomeric ring gasket.

c. Pipe 14 through 36 inch diameter: Joints shall be elastomeric gasket push-on joints made in accordance with AWWA M23.

3.1.5.4 RTRP I, RTRP II and RPMP Pipe

a. RTRP I: Assembly of the pipe shall be done in conformance with the manufacturer's written instruction and installation procedures. Field joints shall be prepared as specified by the pipe manufacturer. Several pipe joints having interference-fit type couplings may be field bonded and cured simultaneously. However, the pipe shall not be moved and additional joints shall not be made until the previously laid joints are completely cured. Joints not having interference-fit type coupling shall be fitted with a clamp which shall hold the joint rigidly in place until the joint cement has completely cured. The clamps shall have a protective material on the inner surface to prevent damage to the plastic pipe when the clamp is tightened in place. The pipe manufacturer shall provide a device or method to determine when the joint is pulled against the pipe stop. Additionally, the pipe manufacturer shall furnish a gauge to measure the diameter of the spigot ends to ensure the diameter conforms to the tolerances specified by the manufacturer. All pipe ends shall be gauged. Factory certified tests shall have been satisfactorily performed to verify that short-term rupture strength is 1,500 psior greater when carried out in accordance with ASTM D 1599. At any ambient temperature, field bonded epoxy-cemented joints shall be cured with a self-regulating, thermostatically temperature controlled, electrical heating blanket for the time and temperature recommended by the manufacturer for the applicable size and type of joint, or by an alternate heating method recommended by the manufacturer and approved by the Contracting Officer. The joint sections shall not be moved during heating, or until the joint has cooled to ambient temperature.

b. RTRP II: A reinforced overlay joint shall be used to join sections together through a placement of layers of reinforcement fiberglass roving, mat, tape or fabric thoroughly saturated with compatible catalyzed resin.

c. Fittings and Specials for RTRP and RPMP Pipe: Metal to RTRP and RPMP pipe connections shall be made by bolting steel flanges to RTRP and RPMP pipe flanges. Cast-iron fitting with gasket bell or mechanical joint may be used with RTRP if pipe has cast iron outside diameter. Steel flanges shall be flat-faced type. Where raised-face steel flanges are used, spacer rings shall be used to provide a flat-face seat for RTRP and RPMP pipe flanges. A full-face Buna "N" gasket 1/8 inch thick with a shore hardness of 50-60 shall be used between all flanged connections. The RTRP and RPMP pipe flange shall have raised sealing rings. Flat washers shall be used under all nuts and bolts on RTRP and RPMP pipe flanges. Bolts and nuts shall be of noncorrosive steel and torqued to not more than 100 foot pounds.Flanges shall not be buried. A concrete pit shall be provided for all flanged connections.

3.1.5.5 Ductile-Iron Pipe Requirements

Mechanical and push-on type joints shall be installed in accordance with AWWA C600 for buried lines or AWWA C606 for grooved and shouldered pipe above ground or in pits.

3.1.5.6 Not Galvanized Steel Pipe Requirements

a. Mechanical Couplings: Mechanical couplings shall be installed in accordance with the recommendations of the couplings manufacturer.

b. Rubber Gaskets: Rubber gaskets shall be handled, lubricated where necessary, and installed in accordance with the pipe manufacturer's recommendations.

3.1.5.7 Galvanized Steel Pipe Requirements

Screw joints shall be made tight with a stiff mixture of graphite and oil, inert filler and oil, or with an approved graphite compound, applied with a brush to the male threads only. Compounds shall not contain lead.

3.1.5.8 Copper Tubing Requirements

Joints shall be made with flared fittings. The flared end tube shall be pulled tightly against the tapered part of the fitting by a nut which is part of the fitting, so there is metal-to-metal contact.

3.1.5.9 Bonded Joints Requirements

Bonded joints shall be installed in accordance with details specified for joints in paragraph JOINTS.

3.1.5.10 Isolation Joints and Dielectric Fittings

Isolation joints and dielectric fittings shall be installed in accordance with details specified in paragraph JOINTS. Dielectric unions shall be encapsulated in a field-poured coal-tar covering, with at least 1/8 inch thickness of coal tar over all fitting surfaces.

3.1.5.11 Transition Fittings

Connections between different types of pipe and accessories shall be made with transition fittings approved by the Contracting Officer.

3.1.6 Installation of Service Lines

Service lines shall include the pipeline connecting building piping to water distribution lines to the connections with the building service at a point approximately 5 feet outside the building where such building service exists. Where building services are not installed, the Contractor shall terminate the service lines approximately 5 feet from the site of the proposed building at a point designated by the Contracting Officer. Such service lines shall be closed with plugs or caps. All service stops and valves shall be provided with service boxes. Service lines shall be constructed in accordance with the following requirements:

3.1.6.1 Service Lines 50 mm (2 Inches) and Smaller

Service lines 2 inches and smaller shall be connected to the main by a directly-tapped corporation stop or by a service clamp. A corporation stop and a copper gooseneck shall be provided with either type of connection. Maximum sizes for directly-tapped corporation stops and for outlets with service clamps shall be as in TABLE I. Where 2 or more gooseneck connections to the main are required for an individual service, such connections shall be made with standard branch connections. The total clear area of the branches shall be at least equal to the clear area of the service which they are to supply.

TABLE I. SIZE OF CORPORATION STOPS AND OUTLET

Pipe Size Inches	Corporation Stops, Inches For Ductile-Iron Pipe	Outlets w/Service Clamps, Inches Single & Double Strap
3	--	1
4	1	1
6	1-1/4	1-1/2
8	1-1/2	2
10	1-1/2	2
12 & larger	2	2

NOTE:

a. Service lines 1-1/2 inches and smaller shall have a service stop.

b. Service lines 2 inches in size shall have a gate valve.

3.1.6.2 Service Lines Larger than 50 mm (2 Inches)

Service lines larger than 2 inches shall be connected to the main by a tapped saddle, tapping sleeve and valve, service clamp or reducing tee, depending on the main diameter and the service line diameter, and shall have a gate valve. Lines 3 inches and larger may use rubber-seated butterfly valves as specified above, or gate valves.

3.1.6.3 Service Lines for Sprinkler Supplies

Water service lines used to supply building sprinkler systems for fire protection shall be connected to the water distribution main in accordance with NFPA 24.

3.1.7 Field Coating and Lining of Pipe

3.1.7.1 Steel Pipe 80 mm (3 In.) and Larger, Not Galvanized

a. Cement-mortar coating and lining: Field jointing shall conform to Appendix, AWWA C205. Any defective area found in the coating and/or lining of pipe and joints shall be removed to the pipe wall and repaired. The repaired areas shall be at least equal in thickness to the minimum coating and/or lining required for the pipe. Steel reinforcement in the coating shall be repaired or replaced as necessary to assure a complete and soundly reinforced coating.

b. Coal-tar enamel coating, lining and wrapping: Field jointing shall conform to AWWA C203. The applied materials shall be tested by means of a spark-type electrical inspection device in accordance with the requirements of AWWA C203. Any flaws or holidays found in the coating and/or lining of pipe and joints shall be repaired by patching or other approved means. The repaired areas shall be at least equal in thickness to the minimum coating and/or lining required for the pipe.

3.1.7.2 Galvanized Steel Pipe, Field Coating

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NOTE: Field coating of joints for galvanized pipe will normally be required only when coating is specified for the pipe.

****

Field joints shall be given 1 coat of coal-tar primer and 2 coats of coal-tar enamel conforming to AWWA C203. The tests of the coating shall conform to AWWA C203, and any flaws or holidays found in the coating of pipe and joints shall be repaired by patching or other approved means; the repaired areas shall be at least equal in thickness to the minimum coating required for the pipe.

3.1.8 Setting of Fire Hydrants, Meters, Valves and Valve Boxes

3.1.8.1 Location of Fire Hydrants

Fire hydrants shall be located and installed as shown. Each hydrant shall be connected to the main with a 6 inch branch line having at least as much cover as the distribution main. Hydrants shall be set plumb with pumper nozzle facing the roadway, with the center of the lowest outlet not less than 18 inches above the finished surrounding grade, and the operating nut not more than 48 inches above the finished surrounding grade. Fire hydrants designated on the drawings as low profile shall have the lowest outlet not less than 18 inches above the finished surrounding grade, the top of the hydrant not more than 24 inches above the finished surrounding grade. Except where approved otherwise, the backfill around hydrants shall be thoroughly compacted to the finished grade immediately after installation to obtain beneficial use of the hydrant as soon as practicable. The hydrant shall be set upon a slab of concrete not less than 4 inches thick and 15 inchessquare. Not less than 7 cubic feet of free-draining broken stone or gravel shall be placed around and beneath the waste opening of dry barrel hydrants to ensure drainage.

3.1.8.2 Location of Meters

[Meters and meter boxes] [Vaults] shall be installed at the locations shown on the drawings. The meters shall be centered in the [boxes] [vaults] to allow for reading and ease of removal or maintenance.

3.1.8.3 Location of Valves

****
NOTE: If valve wrenches are to be provided, add a statement giving the number of valve wrenches to be furnished by the Contractor.
****

After delivery, valves, including those in hydrants, shall be drained to prevent freezing and shall have the interiors cleaned of all foreign matter before installation. Stuffing boxes shall be tightened and hydrants and valves shall be fully opened and fully closed to ensure that all parts are in working condition. Check, pressure reducing, vacuum, and air relief valves shall be installed in valve pits. Valves and valve boxes shall be installed where shown or specified, and shall be set plumb. Valve boxes shall be centered on the valves. Boxes shall be installed over each outside gate valve unless otherwise shown. Where feasible, valves shall be located outside the area of roads and streets. Earth fill shall be tamped around each valve box or pit to a distance of 4 feet on all sides of the box, or the undisturbed trench face if less than 4 feet.

3.1.8.4 Location of Service Boxes

Where water lines are located below paved streets having curbs, the boxes shall be installed directly back of the curbs. Where no curbing exists, service boxes shall be installed in accessible locations, beyond the limits of street surfacing, walks and driveways.

3.1.9 Tapped Tees and Crosses

Tapped tees and crosses for future connections shall be installed where shown.

3.1.10 Thrust Restraint

Plugs, caps, tees and bends deflecting 11.25 degrees or more, either vertically or horizontally, on waterlines 4 inches in diameter or larger, and fire hydrants shall be provided with thrust restraints. Valves shall be securely anchored or shall be provided with thrust restraints to prevent movement. Thrust restraints shall be either thrust blocks or, for ductile-iron pipes, restrained joints.

3.1.10.1 Thrust Blocks

Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2,000 psi after 28 days. Blocking shall be placed between solid ground and the hydrant or fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

3.1.10.2 Restrained Joints

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NOTE: When the restrained length is specified by the designer, this paragraph will be modified to delete the design requirement. The Government's designer should use TM 5-813-5 for guidance.

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For ductile-iron pipe, restrained joints shall be designed by the Contractor or the pipe manufacturer in accordance with DIPRA-Restraint Design.

3.2 HYDROSTATIC TESTS

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NOTE: Test pressure for hydrostatic pressure and leakage tests will be the working pressure multiplied by 1.33. For a working pressure of 1.03 MPa (150 psi), the test pressure will be 1.38 MPa (200 psi). For other working pressures the test pressure will be adjusted accordingly.

****

Where any section of a water line is provided with concrete thrust blocking for fittings or hydrants, the hydrostatic tests shall not be made until at least 5 days after installation of the concrete thrust blocking, unless otherwise approved.

3.2.1 Pressure Test

After the pipe is laid, the joints completed, fire hydrants permanently installed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic pressure test of [200] [_____] psi. Water supply lines designated on the drawings shall be subjected for 1 hour to a hydrostatic pressure test of [200] [_____] psi. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, hydrants, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, hydrants and valves discovered in consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Contracting Officer when one or more of the following conditions is encountered:

a. Wet or unstable soil conditions in the trench.

b. Compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions.

c. Maintaining the trench in an open condition would delay completion of the project.

The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the required hydrostatic tests. Backfill placed prior to the tests shall be placed in accordance with the requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.2.2 Leakage Test

Leakage test shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the water line shall be subjected to not less than [200] [_____] psi pressure. Water supply lines designated on the drawings shall be subjected to a pressure equal to [200] [_____] psi. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section, necessary to maintain pressure within 5 psi of the specified leakage test pressure after the pipe has been filled with water and the air expelled. Piping installation will not be accepted if leakage exceeds the allowable leakage which is determined by the following formula:

L = 0.0001351ND(P raised to 0.5 power)

L = Allowable leakage in gallons per hour
N = Number of joints in the length of pipeline tested
D = Nominal diameter of the pipe in inches
P = Average test pressure during the leakage test, in psi gauge

Should any test of pipe disclose leakage greater than that calculated by the above formula, the defective joints shall be located and repaired until the leakage is within the specified allowance, without additional cost to the Government.

3.2.3 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a 5-day delay, pipelines jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Cement-mortar lined pipe may be filled with water as recommended by the manufacturer before being subjected to the pressure test and subsequent leakage test.

3.2.4 Concurrent Hydrostatic Tests

The Contractor may elect to conduct the hydrostatic tests using either or both of the following procedures. Regardless of the sequence of tests employed, the results of pressure tests, leakage tests, and disinfection shall be as specified. Replacement, repair or retesting required shall be accomplished by the Contractor at no additional cost to the Government.

a. Pressure test and leakage test may be conducted concurrently.

b. Hydrostatic tests and disinfection may be conducted concurrently, using the water treated for disinfection to accomplish the hydrostatic tests. If water is lost when treated for disinfection and air is admitted to the unit being tested, or if any repair procedure results in contamination of the unit, disinfection shall be reaccomplished.

3.3 BACTERIALDISINFECTION

****

NOTE: The option of having the Contracting Officer perform the sampling and testing will be selected only if Government laboratory facilities are available and with concurrence from appropriate laboratory personnel. At some locations, either county or installation health officers inspect the disinfection process. If this is required add a notification requirement and give the office to be notified, with a phone number.

****

3.3.1 Bacteriological Disinfection

Before acceptance of potable water operation, each unit of completed waterline shall be disinfected [as prescribed by AWWA C651.] [as specified. After pressure tests have been made, the unit to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be either liquid chlorine, calcium hypochlorite, or sodium hypochlorite, conforming to paragraph MISCELLANEOUS ITEMS. The chlorinating material shall provide a dosage of not less than 50 ppm and shall be introduced into the water lines in an approved manner. Polyvinyl Chloride (PVC) pipe lines shall be chlorinated using only the above specified chlorinating material in solution. The agent shall not be introduced into the line in a dry solid state. The treated water shall be retained in the pipe long enough to destroy all non-spore forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 25 ppm of free chlorine residual throughout the line at the end of the retention period. Valves on the lines being disinfected shall be opened and closed several times during the contact period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period, each fire hydrant on the line shall be opened and closed several times.] From several points in the unit, [the Contracting Officer will take samples of water in proper sterilized containers for bacterial examination.] [personnel from the Contractor's commercial laboratory shall take at least [3] [_____] water samples from different points, approved by the Contracting Officer, in proper sterilized containers and perform a bacterial examination in accordance with state approved methods. The commercial laboratory shall be certified by the state's approving authority for examination of potable water.] The disinfection shall be repeated until tests indicate the absence of pollution for at least 2 full days. The unit will not be accepted until satisfactory bacteriological results have been obtained.

3.4 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02522 (May 1998)**
U.S. ARMY CORPS OF ENGINEERS **--------------------------**
Superseding
CEGS-02671 (February 1995)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02522

GROUND-WATER MONITORING WELLS
05/98

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NOTE: This guide specification covers the requirements for ground water monitoring wells for hazardous waste sites. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

State and/or local regulations/requirements may also need to be referenced.

****

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 312/A 312M	(1995a) Seamless and Welded Austenitic Stainless Steel Pipes
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 150	(1997) Portland Cement
ASTM C 387	(1995) Packaged, Dry, Combined Materials for Mortar and Concrete
ASTM D 1586	(1984; R 1992) Penetration Test and Split-Barrel Sampling of Soils
ASTM D 1785	(1996b) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2488	(1993) Description and Identification of Soils (Visual-Manual Procedure)
ASTM D 4318	(1995a) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4750	(1987; R 1993) Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)
ASTM D 5079	(1990) Preserving and Transporting Rock Core Samples
ASTM D 5088	(1990) Decontamination of Field Equipment Used at Nonradioactive Waste Sites
ASTM D 5092	(1990) Design and Installation of Ground Water Monitoring Wells in Aquifers
ASTM D 5299	(1992) Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities
ASTM D 5521	(1994) Development of Ground-Water Monitoring Wells in Granular Aquifers

ASTM D 5608	(1994) Decontamination of Field Equipment Used at Low Level Radioactive Waste Sites
ASTM F 480	(1994) Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA EWW	(1995) Standard Methods for the Examination of Water and Wastewater

CODE OF FEDERAL REGULATIONS (CFR)

49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements

ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020	(1984) Methods for Chemical Analysis of Water and Wastes

FORESTRY SUPPLIERS (FSUP)

FSUP Soil Color Chart	(1994) Munsell Soil Color Charts

GEOLOGICAL SOCIETY OF AMERICA (GSA)

GSA RCC-001	(1969) Geological Society of America Rock Color Chart

NSF INTERNATIONAL (NSF)

NSF ANSI/NSF 14	(1996) Plastics Piping Components and Related Materials

1.2 UNIT PRICES

Payment for each specified item will be made at the contract unit price for that item. Payment will include full compensation for equipment, materials and labor for drilling; removal and disposal of temporary casing, cuttings, and drill fluid; preparation of borehole logs; and sample handling, containers, storage, and testing. Depth, logging, installation, casing, riser pipe, and well screen shall be measured by linear distance. Payment will not be allowed for test holes or monitoring wells abandoned due to construction practices not in accordance with this specification, or for the convenience of the Contractor.

1.2.1 Test Holes

If the total depth of the test hole is greater than that specified in the contract for "Test Holes, and Samples," the additional depth will be paid for at the contract unit price for "Additional Test Hole Depth." If the test hole is developed into the permanent monitoring well, no separate payment will be made for the test hole.

1.2.2 Monitoring Well Drilling and Sampling

If the total depth of the monitoring well is greater than that specified in the contract for "Monitoring Wells and Samples," the additional depth will be paid for at the contract unit price for "Additional Monitoring Well Depth."

1.2.3 Geophysical Logging

The "Geophysical Logging" unit price will include interpretation of the logs and their delivery to the Government.

1.2.4 Casing/Riser Pipe Selection and Installation

Payment will be made for length of blank casing actually installed in the well. Payment will include compensation for decontamination and installation of the casing/riser pipe, cap, tail piece (if any), end cap and centralizers; and for the furnishing and installing of the well identification tag with information recorded thereon, or well marking as per contract.

1.2.5 Monitoring Well Screen

Payment will be made for monitoring well screen actually installed in the well.

1.2.6 Filter Pack Construction

Filter pack construction will be measured by the cubic foot. Payment will include compensation for furnishing, delivering, storage, decontamination, analytical testing, and installing the filter pack.

1.2.7 Bentonite Seal

The bentonite seal will be measured by the cubic foot. Payment will include full compensation for hydrating, and tremieing necessary for the work.

1.2.8 Grout Placement

The cement and/or bentonite grout used in the annulus above the bentonite seal will be paid by the cubic foot used. Payment will include compensation for cement, mixing of the grout, and pumping of grout, bentonite, mixing of bentonite grout, and pumping of bentonite grout, necessary for the work.

1.2.9 Monitoring Well Development

Payment for monitoring well development will be made by the hour. Payment will include compensation for pumping, surging, bailing, sample photograph, discharge water containers, and disposal.

1.2.10 Monitoring Well Completion Aboveground

Payment will include compensation for protective covers, keyed-alike padlocks, locking caps, project photographs, concrete well pads, gravel, and protective steel posts.

1.2.11 Monitoring Well or Test Hole Decommissioning/Abandonment

Permanent decommissioning/abandonment of monitoring wells or test holes will be paid for only if it becomes necessary to abandon a well or test hole as specified, and only for work completed and accepted as specified. Payment will include compensation for drilling, casing removal, well sampling, materials, cement, mixing of cement, bentonite, and water, pumping of grout, equipment, removal of foreign objects, and transportation necessary to abandon the well or test hole and for the required well or test hole abandonment records.

1.2.12 Site Cleanup

Separate payment will not be made for cleanup of the site. Cleanup will mean restoring the site to its pre-construction condition, in accordance with paragraph SITE CLEANUP. Cleanup will be considered part of and incidental to the drilling, construction, and/or decommissioning of the monitoring well.

1.3 SYSTEM DESCRIPTION

****

NOTE: Designer must ensure that well design meets or exceeds Federal, state, and local installation requirements. Additional criteria may apply for monitoring wells at radioactive, mixed, biological, solid, or medical waste sites.

****

Each monitoring well shall be constructed to yield chemically representative ground water samples of the screened interval for chemical analysis, and to allow for the accurate measurement of ground water depths relative to the top of the well riser, by use of electrical, wetted tape, or acoustical methods. The screened interval is that portion of a monitoring well which is directly open to the host aquifer by way of openings in the well screen and indirectly open to the aquifer by way of the filter pack (or other permeable material) extending continuously below and/or above the screen.

1.4 PERFORMANCE REQUIREMENTS

Each monitoring well shall be installed to prevent aquifer contamination by the drilling operation and equipment, intra- and inter-aquifer contamination, and vertical seepage of surface water adjacent to the well into the subsurface, especially the monitoring well intake zone.

1.5 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Installation Plan; [_____].

A plan as specified in paragraph INSTALLATION PLAN,describing the drilling methods, sampling, and monitoring well construction and well development [30] [_____] calendar days prior to beginning drilling operations. Mobilization activities may start prior to submittal of the plan. The plan shall be approved and signed by a geologist experienced in hazardous waste projects as specified in paragraph QUALIFICATIONS.

Monitoring Wells; [_____].

Catalog data for monitoring well screens (to include the screen slot size), casing, riser pipe, filter pack material, bentonite, cement, centralizers, surface protective covers, well vaults, locking caps, airline oil filters for pneumatic drilling, dedicated sampling equipment, and chemical specifications on drill lubricants and tracers, if used. Catalog data shall include any information, written or otherwise, supplied by the manufacturers or suppliers of the above listed items.

Drilling Fluid Additive; [_____].

Manufacturer's data, if available, including analytical test results of the additive, if not a part of the manufacturer's data.

SD-04 Drawings

Installation Diagrams, GA.

As-built installation diagram for each monitoring well installed, prepared by the geologist present during well installation operations, within [_____] working days of the completion of the well installation procedure.

SD-09 Reports

Survey Maps and Notes; [_____].

Survey maps and notes, including a tabulated list of all monitoring wells and monuments, copies of all field books, maps showing the locations, and elevations of all monitoring wells, and all computation sheets shall be submitted within [_____] working days after completion of the survey.

Borehole Logs; [_____].

Original borehole logs, within [_____] working days after completion of the boring and well installation procedures.

Installation Diagrams; [_____].

An installation diagram for each monitoring well shall be submitted within [_____] working days of the completion of the installation.

Well Development Records; [_____].

A monitoring well development record, for each monitoring well, within [_____] working days of the completion of development.

Geophysical Logs; [_____].

Geophysical logs shall be submitted within [_____] working days of the completion of said logging.

Decommissioning/Abandonment Records; [_____].

A well decommissioning record, for each well, or test hole abandoned, within [_____] working days of the completion of the abandonment procedure.

Project Photographs; [_____].

Before, during, and after completion of the work, the Contractor shall take photographs of each well installation site. Photographs shall also be taken of any rock that is cored at the site.

Water Source; [_____].

Decontamination and drilling water source analytical test results.

Filter Pack; [_____].

Filter pack material test results; sieve and chemical analyses.

SD-18 Records

Qualifications; [_____].

Personnel qualification documentation.

Permits; [_____].

A copy of all permits, licenses, or other requirements necessary for execution of the work. Before beginning work, the local United States Geological Survey office (USGS) [and the] [State Environmental Protection office] [State Geological Agency] [state health department] [local health department] [Department of natural Resources]shall be notified of the type and location of wells to be constructed, the method of construction and anticipated schedule for construction of the wells. A copy of all such correspondence shall be furnished.

1.6 INSTALLATION PLAN

****

NOTE: The Monitoring Well Installation Plan may need to be included as a part of the Field Sampling Plan (FSP) which is a part of the Sampling and Analysis Plan (SAP) required in Section 01450 CHEMICAL DATA QUALITY CONTROL. The FSP is described

in EM 200-1-3, Requirements for the Preparation of Sampling and Analysis Plans. EM 200-1-3 outlines the SAP format requirements, which include monitoring well installation.
****

The following requirements shall be incorporated into the Contractor's Monitoring Well Installation Plan and followed in the field. The plan shall include, but shall not be limited to, a discussion of the following:

a. Description of well drilling methods, and installation procedures, including any temporary casing used, placement of filter pack and seal materials, drill cuttings and fluids disposal, and soil/rock sample disposition.

b. Description of well construction materials, including well screen, riser pipe, centralizers, tailpiece (if used), filter pack and filter pack gradation, bentonite, drilling fluid additives (if used), drilling water, cement, and well protective measures.

c. Description of quality control procedures to be used for placement of filter pack and seals in the boring, including depth measurements.

d. Forms to be used for written boring logs, installation diagrams of wells, geophysical logs, well development records, well sampling data records, state well registration forms, and well abandonment records.

e. Description of contamination prevention and well materials and equipment decontamination procedures.

f. Description of protective cover surface completion procedures, including any special design criteria/features relating to frost heave prevention. The maximum frost penetration for the site shall be included in this description.

g. Description of well development methods to be used.

h. List of applicable publications, including state and local regulations and standards.

i. List of personnel assignments for this project, and personnel qualifications.

j. Description of well decommissioning/abandonment procedures.

k. Description of in-situ permeability determination techniques, if testing is required.

l. Description and discussion of geophysical techniques to be employed at the site.

1.7 QUALIFICATIONS

A geologist with at least [3] [_____] years experience in hazardous waste projects, soil and rock logging, and monitoring well installation, registered in the state of [_____], shall be onsite and responsible for all geophysical and borehole logging, drilling, well installation, developing and testing activities. The driller shall be licensed in the state of [_____], according to the state requirements. Geophysical log interpretation shall be done by a qualified log analyst. The log analyst shall be able to demonstrate competence through background, training, and experience when so called upon. The Contractor shall have a minimum of [_____] years of monitor well installation experience. The Contractor's staff shall include appropriate health and safety personnel as specified in Section 01351 SAFETY, HEALTH AND EMERGENCY RESPONSE (HTRW/UST), and personnel qualified to perform the necessary chemical sampling as presented in the approved Sampling and Analysis Plan, prepared as specified in Section 01450 CHEMICAL DATA QUALITY CONTROL.

1.8   NOTIFICATION

The [Installation Environmental Coordinator (IEC)] [_____] and the Contracting Officer shall be notified [_____] days prior to drilling. The [Contracting Officer] [Contractor] [Installation Environmental Coordinator (IEC)] [_____] [will] [shall] be responsible for contacting the [State of [_____]] [USEPA] in accordance with the applicable reporting requirements.

1.9   DELIVERY, STORAGE, AND HANDLING

Monitoring well materials shall be stored and maintained in a clean, uncontaminated condition throughout the course of the project.

1.10   SITE CONDITIONS

****

NOTE: If needed, edit and add Section 02230 CLEARING AND GRUBBING.

****

Access to each monitoring well site, including any utility clearance, permits, licenses, or other requirements and the payment thereof necessary for execution of the work is the responsibility of the [Contractor] [Government]. Obtaining rights-of-entry is the responsibility of the [Contractor] [Government]. The Contractor shall visit each proposed well location to observe any condition that may hamper transporting equipment or personnel to the site. If clearing or relocation is necessary, the Contractor, Installation Environmental Coordinator, and the Contracting Officer shall agree on a suitable clearing, or relocation plan and the location of any required access road.

PART 2   PRODUCTS

2.1   WELL CASING

****

NOTE: The selection of well casing/riser pipe, and screen materials should be made with due consideration to geochemistry, anticipated lifetime of the monitoring program, well depth, chemical parameters to be monitored, and other site-specific factors. Normally 50 or 100 mm (2 or 4 inch) inside diameter well casing, and screen should be used; however, larger casing diameters may be necessary where dedicated purging, or sampling equipment is used, or where the well is screened in a deep

formation. Schedule 40 casing is commonly used for monitoring wells, but schedule 80 is sometimes used for larger diameter PVC casing.

Welding is not a recommended procedure for the installation of a monitoring well; however, there may be occasions when it is necessary to weld outer/protective casing, or drive casing at the site. It may be unsafe to weld if certain volatile organics are present. Safety precautions should be addressed in the site safety and health plan. In addition to the safety consideration, it may be undesirable to use metal well casing if metals are the contaminants of concern, which would preclude welding of metal well pipe. Appropriate welding standards, such as AWWA C206, Field Welding of Steel Water Pipe, must be referenced if welding is anticipated.

****

Monitoring well casing/riser pipe, shall be new, [4] [_____] inch nominal internal diameter, schedule [40] [_____] flush-joint threaded [[ASTM D 1785 polyvinyl chloride (PVC)] [PTFE] [_____] pipe. This pipe shall also meet the requirements of NSF ANSI/NSF 14. Required fittings shall be ASTM F 480 flush thread male by female fittings] [Type 304 stainless steel. The minimum wall thickness shall be schedule 5S meeting the requirements of ASTM A 312/A 312M]. Pop rivets, or screws shall not be used. A [PVC] [stainless steel] [PTFE] [_____], [locking] [non-locking] cap, that threads or slips onto the top of the well casing shall be provided.

2.2 CENTRALIZERS

[Stainless steel] [PVC] [PTFE] centralizers shall be attached to the well casing when monitoring wells are over [20] [_____] feet in length. Centralizers will not be required if the monitoring wells are installed through hollow-stem augers.

2.3 WELL SCREEN

****

NOTE: Continuous wrap screen is commonly used for monitoring wells. This type screen is not normally designated by schedule; however, the end fittings are, and must be, compatible with the schedule of the well casing. Thus the schedule of the end fittings of the screen must be specified. The schedule of the screen must be specified, however, if slotted pipe well screen is required. The screen slot size for monitor wells is commonly 0.25 mm (0.010 inch) for fine-grained formations or 0.5 mm (0.020 inch) for coarser grained formations. In most monitoring wells, because optimum yield from the well is not as critical to achieve as it is in production or extraction wells, and because extensive development is more difficult to accomplish in small diameter wells, screens are

usually designed to have smaller openings, so that less formation material will be pulled into the well during the development and sampling. Monitoring well screen length is typically 1.5 to 3 meters (5 to 10 feet), but should be designed for the particular case to be monitored; however, when monitoring ground water quality at the top of the water table, screen lengths of 3 and 6 meters (10 and 20 feet) are commonly used. Screens of more than 6 meters (20 feet) are rarely used.
****

The design and construction of the monitoring well screen shall be in accordance with paragraph SYSTEM DESCRIPTION. Monitoring well screens shall consist of new commercially fabricated flush-joint threaded [4] [_____] inch nominal internal diameter [polyvinyl chloride (PVC)] [type 304 stainless steel] [_____][continuous wrap] [schedule [40] [_____] slotted], non-clogging design. [The end fittings on the continuous wrap screen shall be schedule [40] [_____].] Required fittings shall be ASTM F 480 flush thread male by female fittings. The screen slot size shall be [determined by the Contractor, and approved by the Government] [[0.010] [0.020] [_____] inch.] The screen length shall be [[_____] feet] [determined by the Contractor]. The bottom section of the screen shall be sealed watertight by means of a flush threaded end cap of the same material as the well screen and shall be within 6 inches of the open portion of the screen.

2.4 FILTER PACK

Filter pack shall consist of clean, washed, rounded to sub-rounded siliceous material free from calcareous grains or material. Organic matter, soft, friable, thin, or elongated particles are not permissible. The gradation of the filter pack shall be determined using the grain size analysis data obtained as required in paragraph Sampling. The uniformity coefficient of the filter pack material shall not exceed 2.5. An airtight pint size [plastic] [glass] container shall be filled with a sample of filter pack material and furnished to the Contracting Officer for each well to serve as a quality control.

2.5 BENTONITE SEAL

****
NOTE: Slurry seals can be used as when the seal location is too far below water to allow for pellet or containerized-bentonite placement, or within a narrow well-borehole annulus.

See paragraph BENTONITE SEAL note.
****

The bentonite seal, intended to keep grout from entering the filter pack, shall consist of hydrated granular, or pelletized, sodium montmorillonite furnished in sacks or buckets from a commercial source and shall be free of impurities which adversely impact the water quality. If the bentonite seal is located above any borehole fluid levels, a layer of fine sand shall be placed at the top of the bentonite seal, to provide an additional barrier to any downward migration of grout.

2.6 CEMENT AND BENTONITE GROUT

Cement grout shall be a mixture of a maximum of 7 gallons of approved water per 94 lb bag of Portland cement, which conforms to ASTM C 150, Type [I] [_____]. Not more than 5 percent by weight of bentonite powder shall be added to reduce shrinkage and to hold the cement in suspension prior to the grout set. High-solids bentonite grout shall be made from sodium bentonite powder and/or granules. Water from an approved source shall be mixed with these powders or granules to form a thick bentonite slurry. The slurry shall consist of a mixture of bentonite and the manufacturer's recommended volume of water to achieve an optimal seal. The slurry shall contain at least 20 percent solids by weight and have a density of 9.4 lb per gallon of water or greater. Additional construction details for grout placement above the bentonite seal for frost heave protection shall be as directed in paragraph Protective Cover Placement.

2.7 CONCRETE PAD OR GRAVEL BLANKET

A [concrete pad] [coarse gravel blanket] shall be constructed around the protective cover at the ground surface.

2.8 PROTECTIVE COVERS

Monitoring wells shall have [a steel] [a stainless steel] [a cast iron] [an aluminum] lockable protective casing/enclosure set over the well casing. The protective cover shall be set in the concrete pad or surface seal. Weather resistant padlocks which use the same key (keyed-alike) shall be provided on the protective covers, or lockable caps for all wells. Any well that is to be temporarily removed from service or left incomplete due to delay in construction shall be capped with a watertight cap and equipped with a vandal resistant cover.

2.9 PROTECTIVE POSTS

[Four] [_____] [3] [_____] inch diameter, [schedule 40 carbon steel] [_____], [6] [_____] foot long, primed and painted [orange] [_____] protective posts shall be placed around the monitoring well. Primer and paint shall conform to Section 09900PAINTING, GENERAL.

2.10 CONTAINERIZATION OF DEVELOPMENT WATER, AND DRILL CUTTINGS

Water removed during development and testing operations, and cuttings from the drilling operations shall be contained in D.O.T.-approved drums, containers or vessels as specified in 49 CFR 172. The Contractor shall furnish polyethylene and steel drums with lids, lid gaskets, bolts, chain of custody forms and drum labels. The Contractor shall mark each drum label in accordance with 49 CFR 172 in addition to the following information: drum number, site name, well name and number, contents and date, approximate depth of material contained in each drum and the name and phone number of the [Installation Environmental Coordinator (IEC)] [Contracting Officer] [_____].

2.11 SAMPLE CONTAINERS

****

NOTE: Delete requirements for boxing core, if rock coring is not anticipated at the site. Rock core samples should be containerized, boxed and stored in

accordance with ER 1110-1-1803, EM 200-1-3, EM 1110-1-1804, and EM 1110-1-4000.
****

Cuttings and driven samples for geotechnical purposes shall be placed in air-tight pint size [plastic] [glass] containers and labeled with the project name, date of sample, monitoring well number and depth at which the sample was taken. Both the container and lid shall be labeled in permanent indelible ink. Jars shall be placed in partitioned [cardboard] [_____] boxes. Boxes shall be labeled with project number and well number. Containers and boxes shall be furnished by the Contractor. Core samples shall be preserved and prepared for transport as described in ASTM D 5079. Cored rock samples shall be placed in [wooden] [_____] core boxes as indicated on the drawings. Spacers shall be placed in the proper positions in the core boxes to show the location and actual extent of voids and core losses as clearly as possible. The spacers shall be made of [wood] [_____] [or some other relatively light material] which is of sufficient strength to withstand jarring and crushing in handling. Spacers shall be of a strongly contrasting color pattern so that core losses will be accented either by direct observation or in photographs. In the smaller sizes, up to and including 6 inches, the spacers shall be the same width as the cores. The outside and the inside of the core box lid shall be labeled with the project name, hole number, date sampled, location, surface elevation, core box number, and interval of depth of core. The information on the label shall be such that it can clearly be read in photographs of the core box. Both ends of the core box shall also be labeled with the hole number and box number. The core shall be placed in the core box starting at the left hand corner on the hinge side and running to the right. Successive cores down the hole shall be placed in successive troughs, starting from the back and working toward the front of the box so that the core can be read in the same manner as a printed page, from left to right, when standing in front of the open box.

PART 3 EXECUTION

3.1 PROTECTION OF EXISTING CONDITIONS

The Contractor shall maintain existing survey monuments and monitoring wells, and protect them from damage from equipment and vehicular traffic. Any items damaged by the Contractor shall be repaired by the Contractor. Monitoring wells requiring replacement due to Contractor negligence shall be re-installed according to these specifications. Wells scheduled for abandonment shall be protected from damage so that abandonment may be performed according to these specifications. Prior to excavation, the Contractor shall obtain written approval from the local utility companies to drill at each site, to avoid disturbing buried utilities.

3.2 PREPARATION

3.2.1 Decontamination

The drill rig, drill rods, drill bits, augers, temporary casing, well developing equipment, tremie pipes, grout pumping lines, and other associated equipment shall be cleaned with high-pressure hot water/steam prior to drilling at each monitoring well location. Decontamination shall be done in accordance with ASTM D 5088 ASTM D 5608. Decontamination shall be performed at a central decontamination station. Cleaning shall be performed in an area that is remote from, and cross- or down-gradient from the well being drilled. Screen and well casing shall be cleaned with high-pressure hot water immediately prior to installation in the well. The use of factory sealed (plastic wrapped) screen and well casing does not waive this requirement for pre-installation cleaning. Samplers shall be decontaminated in accordance with the Sampling and Analysis Plan. The water used for cleaning shall be from a Government approved source. The water source used for cleaning shall be sampled and tested for the constituents specified in the Sampling and Analysis Plan prior to use at the site.

3.2.2 Decontamination Station

The Contractor shall construct a temporary decontamination pad onsite. The pad shall be bermed and slightly inclined towards a sump located in one of the back corners of the pad. Plastic sheeting shall line the pads and berms to contain decontamination water. Plywood sheeting, exterior grade, shall be placed over the plastic sheeting to prevent damage to the plastic and allow the drill rig and heavy equipment to use the pad. The minimum dimensions of the pad shall be the length and width of the drill rig, plus 4 feet per side to allow access and steam cleaning. Yellow ribbon shall be used to encircle the decontamination pad. Water collected in the sump shall be pumped using a "trash" pump to transfer water to a 55 gallon drum labeled "Decontamination Pad Sump Water." Solid waste shall be transferred to a separate 55 gallon drum labeled "Decontamination Pad Sump Sludge."

3.2.3 Water Source

If well drilling/installation requires the use of water, prior to its use at the site, the water source shall be sampled and tested, and approved by the Contracting Officer for the constituents specified in the Sampling and Analysis Plan. The Contractor shall be responsible for locating the source, obtaining the water from the source, transporting it to, and storing it at the site. A water sample shall be obtained from the container used in transporting the water to the site before the water is used for decontamination. This sample shall be tested and approved in accordance with the above requirements.

3.3 INSTALLATION

3.3.1 Drilling Method

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NOTE: Delete prohibition against drilling aids where such aids are required and not otherwise prohibited.

****

The drilling method shall prevent the collapse of formation material against the well screen and casing during installation of the well. The inside diameter of any temporary casing used shall be sufficient to allow accurate placement of the screen, riser, centralizer(s), filter pack, seal and grout. The use of drilling aids such as bentonite, other clay-based agents, or any other foreign matter capable of affecting the characteristics of the ground water is prohibited. Any drilling fluid additive used shall be inorganic in nature. Grease or oil on drill rods, casing, or auger joints are not permitted; however, PTFE tape or vegetable oil (in solid phase form) are acceptable. The drill rig shall be free from leaks of fuel, hydraulic fluid, and oil which may contaminate the borehole, ground surface or drill tools. During construction of the wells, precautions shall be used to prevent tampering with the well or entrance of foreign material. Runoff shall be prevented from entering the well during construction. If there is an interruption in work, such as overnight shutdown or inclement weather, the well opening shall be closed with a watertight uncontaminated cover. The cover shall be secured in place or weighted down so that it cannot be removed except with the aid of the drilling equipment or through the use of drill tools.

3.3.2 Test Hole Requirements

One test hole shall be drilled for every monitoring well or well cluster installed. A well cluster, as defined in this specification, is two or more wells completed (screened) to different depths in a single borehole or in a series of boreholes in close proximity (10 feet or less) to each other. The test hole may be converted to the permanent monitor well. Test holes shall be logged in accordance with paragraph BOREHOLE LOGS. If temporary casing is used, it shall be in accordance with paragraph Decontamination.

3.3.3 Sampling

****

NOTE: Sampling for chemical and geotechnical analysis may be combined to allow for obtaining samples for both if that accomplishes project requirements. If this is done, however, the geotechnical sampling must be coordinated with the requirements in Section 01450 CHEMICAL DATA QUALITY CONTROL for sampling for chemical analysis. If rock is cored at the site, and it is determined that it should be retained, it should be boxed, and photographed. Its storage, and later disposal should be in accordance with ER 1110-1-1803, and the proper storage and handling protocol for such material as may be required by other Federal, state, or local laws, regulations and permits. Sampling procedures are described in EM 200-1-3, Requirements for the Preparation of Sampling and Analysis Plans. Guidance for preserving and preparing core samples for transport can be found in ASTM D 5079

****

3.3.3.1 Sampling for Chemical Analysis

Sampling requirements for obtaining and preserving samples for chemical analysis shall be included in the Sampling and Analysis Plan.

3.3.3.2 Sampling for Geotechnical Analysis

Samples shall be taken of all materials penetrated by each drilled well/test hole. Soil sampling shall be done with a stainless steel split tube sampler using standard sampling techniques in accordance with ASTM D 1586. Samples shall be extracted from their in-situ environment in as near an intact, minimally disturbed condition as technically practical. Samples shall be retrieved according to ASTM D 1586 at least every [5] [_____] feet from each test hole. Samples shall be obtained continuously through the area expected to be screened. The Contractor shall provide sieve analyses of all drive sampled material. Sieve analyses shall be conducted in accordance with ASTM C 136. Drive sample tools shall be cleaned with high-pressure hot water/steam between sampling events within the same boring. Drive-sampled materials shall be placed in airtight containers and labeled as specified in paragraph SAMPLE CONTAINERS. Samples shall be delivered to the Contracting Officer designated facility. Representative soil samples shall be tested for grain-size distribution by mechanical means (sieves down to the No. 200 size according to ASTM C 136), moisture content according to ASTM D 2216 and Atterberg limits according to ASTM D 4318. Description and identification of soils shall be done in accordance with ASTM D 2488. Laboratory classification of soils shall be done in accordance with ASTM D 2487. Sampling shall be performed to allow completion of the documents described in paragraph Borehole Logs.

3.3.4 Geophysical Logging

****
NOTE: The requirement to obtain borehole geophysical surveys is optional. While it may not be necessary to require a borehole geophysical survey at a site where a great deal is known about the subsurface, at another site, where very little, or nothing is known, it may be prudent to require a borehole geophysical survey. When it is deemed necessary to require a borehole geophysical survey, the specific type of survey should be specified. This recommendation is made by the project geologist. The project geologist should also determine what geophysical logging is not allowed by state regulations, before specifying them. See EM 1110-1-1802, Geophysical Exploration. Guidance for planning and conducting borehole geophysical logging may be found in ASTM D 5753.
****

The total depth of each test hole drilled shall be geophysically logged. Geophysical logging shall be documented in accordance with paragraph Geophysical Logs. The Contractor shall run [one successful natural gamma ray or gamma-gamma for the full depth, (top to bottom of test hole);] [one successful neutron in the fluid filled portion of the hole, (top to bottom of test hole);] [one successful (top to bottom of test hole) spontaneous potential (self-potential);] [and,] [one successful (top to bottom of test hole) resistivity log], for each test hole. Log analyses and interpretations shall be made by a person qualified in accordance with paragraph QUALIFICATIONS.

3.3.5 Borehole Diameter and Depth

****
NOTE: State regulations may require more than 50 mm (2 inches) of annular space between the boring wall and the sides of the entered riser pipe and screen.
****

The borings for monitoring well installation shall be of sufficient diameter to permit at least 2 inches of annular space between the boring wall and all sides of the centered riser pipe and screen. Depths of individual borings shall be [determined as specified in the approved

Monitoring Well Installation Plan] [as indicated on the drawings] [_____]. The actual depth of the monitoring well shall be adequate to allow for the collection of representative ground water samples for chemical analysis at the time of initial sampling.

3.3.6 Screen, Well Casing/Riser Pipe Placement

****

NOTE: Depending on the nature of the contaminants to be sampled, the screen may be required to be placed below or across the water table. Caps for the flush-to-ground, or manhole type surface completion should not be vented, or loose fitted. Caps for these type completions should be water tight. Delete the requirements for centralizers if they are not required per paragraph CENTRALIZERS.

****

The monitoring well screen length shall be [as shown on the drawings] [[____] feet long] [determined by the Contractor and approved by the Government], with specified bottom cap securely attached, set to the appropriate depth. The bottom of the well screen shall be placed no more than 3 feet above the bottom of the drilled borehole. The well screen shall be placed in the appropriate location in the borehole so that the completed monitoring well functions in accordance with paragraphs SYSTEM DESCRIPTION and WELL ACCEPTANCE. The Contractor shall provide sieve analyses of all drive sampled material. Sieve analyses shall be conducted in accordance with ASTM C 136. The well screen shall be placed [as specified on the drawings] [at [_____]]. The screen and well casing/riser pipe sections shall be joined by flush threaded watertight joints. The well casing/riser pipe shall extend upwards from the screen to an elevation appropriate for the surface completion described in paragraph Protective Cover Placement. The well screen and riser pipe shall not be dropped or allowed to fall uncontrolled into the borehole. Screen and well casing/riser pipe shall be cleaned with high pressure hot water/steam just prior to installation; foreign material shall not remain on the screen and well casing before installation. The use of factory-sealed (plastic wrapped) screen, free from painted markings, does not waive requirements for pre-installation cleaning. Joints and fastenings shall be watertight and flush threaded; solvent glue or set screws shall not be used. The well shall be plumb, and centered in the hole by the use of a minimum of [_____] stainless steel centralizers, in accordance with paragraph CENTRALIZERS. The centralizers shall be spaced 120 degrees apart at intervals not exceeding [20] [_____] feet along the length of the casing. Centralizers shall not be placed on the screened interval or within the bentonite seal. The alignment of the well shall be verified by passing a 5 foot long section of rigid pipe 1/4 inchsmaller in diameter than the inside diameter of the casing through the entire well. If the pipe does not pass freely, the well will not be accepted. The pipe section shall be thoroughly cleaned with high pressure hot water prior to each test. Temporary casing, hollow stem augers or other measures shall be used, as necessary, to prevent collapse of the boring against the well screen and well casing/riser pipe prior to placement of the filter pack and sealing materials. A cap shall be installed on the top of the riser pipe. Caps shall be either vented, or a telescopic fit, constructed to preclude binding to the well casing caused by tightness of fit, unclean surfaces, or weather conditions. In either case it shall be secure enough to preclude the introduction of foreign material into the well, yet allow pressure equalization between the well and the atmosphere.

3.3.7 Filter Pack Placement

After the screen and well casing have been concentrically placed in the hole, the approved filter pack shall be constructed around the screen by filling the entire space between the screen and the wall of the hole over the selected screened interval. The lowermost [1] [_____] foot of filter pack shall be placed in the boring prior to installation of the well screen and shall serve as a base on which to place the screen. A tremie pipe having an inside nominal diameter of not less than 1 inch, shall be lowered to the bottom of the annulus between the hole and well. The tremie pipe shall be cleaned with high pressure hot water/steam prior to each use. The tremie pipe shall be arranged so that water and filter pack material fed at uniform rates are discharged as the filter pack material fills the hole from the bottom up. The tremie pipe shall be raised at a rate that will keep the bottom of the pipe no more than [5] [_____] feet above the top of the surface of the filter pack level, and no more than [2] [_____] feet below the surface of the filter pack level at all times. Dumping filter pack material from the surface of the ground and agitating the well in an effort to settle the filter material will not be allowed. The filter pack shall be installed continuously and without interruption until the filter pack has been placed [to a minimum of 3 feet above the top of the screen in the monitoring well] [to a height equal to 20 percent of the length of the screen] [to within no more than [______] feet of the top of the ground surface]. The depth to the top of the filter pack shall be directly measured, and recorded. Any water added to the filter pack material shall be obtained in accordance with paragraph Water Source. Filter pack material shall be protected from contamination prior to placement by either storing it in plastic lined bags, or in a location protected from the weather and contamination on plastic sheeting. Filter pack material shall be transported to the well site in a manner which prevents contamination by other soils, oils, grease, and other chemicals. Temporary drill casing, if installed, or auger shall be removed simultaneously with the above operation. Lifting of the riser pipe shall be minimized when withdrawing the temporary casing/auger. Filter pack material shall be placed in no greater than 3 foot lifts prior to retraction of the temporary casing/auger. A minimum of 6 inches of filter pack shall remain in the temporary casing/auger at all times during filter pack installation. Frequent measurements shall be made inside the annulus during retraction to ensure that the filter pack is properly placed.

3.3.8 Bentonite Seal

****

NOTE: Sufficient time should be allowed for the bentonite seal to hydrate and form a low permeable seal before grout is placed in the annular space above the bentonite seal. By not allowing enough time, grout material could infiltrate into the seal and possibly into the filter pack. It is recommended waiting a minimum of 3 to 4 hours for hydration of bentonite pellets, or tablets. If bentonite chips are used, the minimum hydration time could be twice as long. Normally bentonite chips should only be used if it is necessary to install a seal in a deep water column. Because of their high

moisture content and slow swelling tendencies, chips can be dropped through a water column more readily than a material with low moisture content, such as pellets or tablets. Bentonite chips should not be placed in the vadose zone. When installing a bentonite seal in the vadose zone, potable water should be added to the bentonite for it to properly hydrate. The amount of water is dependent on the formation. It is recommended that the bentonite seal be placed in lifts, with each lift allowed to hydrate for a minimum period of time. For more guidance consult EM 1110-1-4000.
****

A minimum 3 foot thick hydrated bentonite seal shall be placed on top of the filter pack in a manner which prevents bridging of the bentonite in the annulus. The bottom of the bentonite seal shall be a minimum of 3 feet above the top of the filter pack. The depth to the top of the bentonite seal shall be directly measured, and recorded immediately after placement, without allowance for swelling. If the bentonite seal is located above any borehole fluid levels, a [1] [_____] foot layer of fine sand shall be placed at the top of the bentonite seal.

3.3.9 Grout Placement

****
NOTE: There is a provision for placing a high-solids bentonite grout in the annulus above the bentonite seal rather than cement grout. This may be better in areas of the country where the monitoring wells will be susceptible to frost heave. If it is required that the protective casing be anchored in-place with cement grout, this should be done in accordance with paragraph Protective Cover Placement. The depth of maximum frost penetration should be determined before design of the monitoring well installation. The susceptibility of the soils to frost action should also be determined beforehand. Guidance for determining frost penetration may be found in TM 5-852-6 or FM 5-430-00-1. There may be a need for a provision to grout the annular space in lifts in deep wells to ensure that any PVC or other type casing will not be collapsed by the weight and/or heat created by the chemical reaction of cement grout. If grouting in lifts is for some reason not acceptable, the well should be designed to withstand greater external pressures. This may mean using higher schedule casing, or steel instead of PVC, for example.
****

A [non-shrinking cement] [high-solids bentonite] grout, shall be mechanically mixed in accordance with paragraph CEMENT AND BENTONITE GROUT, and placed in one continuous operation into the annulus above the bentonite seal to [within [_____] feet of] [the ground surface] [the maximum depth of frost penetration (frost line)]. Grout injection shall be in accordance with ASTM D 5092. If the casing interval to be grouted is less than 15 feet, and without fluids after any drill casing is removed,the grout may be placed either by pouring or pumping. The tremie pipe shall be thoroughly cleaned with high pressure hot water/steam before use in each well. The bottom of the tremie pipe shall be constructed to direct the discharge to the sides rather than downward. The discharge end of the tremie pipe shall be submerged at all times. Additional grout shall be added from the surface to maintain the level of the grout at the land surface as settlement occurs. Work shall not be conducted in the well within [24] [_____] hours after cement grouting. The alignment of the well shall be verified by passing a 5 foot long section of rigid [PVC] [stainless steel] [PTFE] [_____] pipe 1/4 inch smaller in diameter than the inside diameter of the casing through the entire well. If the pipe does not pass freely, the well will not be accepted. The pipe section shall be thoroughly cleaned with high pressure hot water/steam prior to each test.

3.3.10 Concrete or Gravel Pad Placement

****

NOTE: Some states may require that the surface seal extend to depths of 3 m (10 feet), or greater to ensure sanitary protection of the well. The surface seal may be an extension of the annular seal installed above the filter pack or it may be a separate "surface" seal emplaced on top of the annular seal. Also, in extreme cold climates, it may be better, if allowed by state and local regulations, to fill the annular space above the bentonite well seal, or filter pack, with bentonite grout and construct the well "pad" of coarse gravel, rather than concrete. Concrete well pads sometimes have a tendency to crack and breakup in cold regions.

****

A [concrete pad with a minimum radius of [2] [_____] feet from the protective casing and 4 inch] [coarse gravel blanket with a minimum radius of [4] [_____] feet from the protective casing and 6 inch] thick, sloped away from the well shall be constructed around the well casing at the final ground level elevation. [Prior to placement of the gravel blanket, any depression existing around the well borehole shall be backfilled to the level of the surrounding ground surface with [near-surface drill cuttings from the well] [clay] [_____].] [Concrete for the well pads shall be furnished as pre-packaged, dry, combined materials for concrete and shall conform to ASTM C 387 normal weight, normal strength concrete. The dry materials shall be combined with potable water and mixed in an approved mixer or container until uniform in consistency and color. Water shall be limited to the minimum amount possible.]

3.3.11 Protective Cover Placement

****

NOTE: If frost heave is not a concern at the site, the requirement for the annular space between the protective casing and the well riser to be filled with dry bentonite may be deleted. The cement grout may then be placed outside of, and inside the protective casing to the ground surface as would be

specified in paragraph Grout Placement.

It may be necessary to require that the protective posts be supplemented with barbed wire in livestock grazing areas. Additional guidance on monitoring well protection may be found in ASTM D 5787
****

Monitoring wells shall have a [steel] [_____] lockable protective enclosure set in the annular seal over the well casing. Keyed-alike locks shall be provided on the protective covers for all wells.

3.3.11.1   Protective Steel Casing

****
NOTE: Delete this paragraph if not applicable for the project.
****

A protective steel casing shall be installed around the well casing/riser pipe by placing the protective casing into the annular seal. The protective casing shall be cleaned with high-pressure hot water/steam prior to installation to ensure that it is free of any contamination. The protective casing inside diameter shall be at least 4 inches greater than the nominal diameter of the well riser. The protective casing shall be fitted with a locking cap and installed so that there is a maximum 0.2 foot clearance between the top of the in-place inner well casing cap and the bottom of the protective casing locking cap when in the locked position. The protective casing shall be positioned and maintained in a plumb position. The bottom of the protective casing shall extend a minimum of 2.5 feet below the top of the ground surface; shall extend a minimum of [2.5] [_____] feet below the maximum depth of frost penetration (frost line); shall be anchored into the cement grout annular seal; and shall extend at least 2.5 feet above the surface of the ground. The protective casing shall be sealed and immobilized in concrete placed around the outside of the protective casing. Dry bentonite pellets, or granules, shall then be placed in the annular space below ground level within the protective casing. The protective casing shall have a 1/4 inch diameter drain hole installed just above the top of the [concrete pad] [gravel blanket]. Coarse sand or pea gravel shall be placed in the annular space between the protective casing and the riser pipe, above the drain hole, to within 3 inches from the top of the riser pipe. [Four] [_____] protective steel posts shall be installed, located 4 feet from the well, equally spaced around the [concrete pad] [gravel blanket]. The steel posts shall be filled with cement. The posts shall not be installed in the concrete pad, but from a 0.5-1.0 foot distance from the edge of the concrete pad. The posts shall be set in cement, and shall extend a minimum of 3 feet above the ground surface. One third of the posts' total length shall be below ground surface.

3.3.11.2   Flush-to-Ground Utility Vault

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NOTE: Delete this paragraph if not applicable for the project.
****

A flush-to-ground protective steel utility vault or manhole shall be installed around the well casing/riser pipe which has been cut off below grade. The flush mounted protective utility vault or manhole shall be constructed with a concrete ground surface seal. The ground surface seal shall extend to, but not beyond, the total depth of the flush mounted protective utility vault. The ground surface seal shall be installed around the flush mounted protective utility vault and shall not be placed between the flush mounted protective utility vault and the well casing. The flush mounted protective utility vault shall not be installed in areas subject to ponding or flooding. The flush mounted protective cover's lid or manhole cover shall have the wording "ground-water monitoring well" on its outer surface. Flush mounted protective utility vaults shall be installed through an impervious surface such as asphalt or concrete. If an impervious surface does not exist, one shall be created to support the weight of the traffic in the area. The flush mounted protective utility vault shall consist of a watertight metal casing with an inside diameter at least 4 inches greater than the inside diameter of the monitoring well casing. The flush mounted protective utility vault shall be one continuous metal piece or two metal pieces which are joined with a continuous weld. The flush mounted protective utility vault shall be a minimum of [12] [_____] inches in length. There shall be no more than 8 inches between the top of the monitoring well casing and the top of the flush mounted protective utility vault after installation. The flush mounted protective utility vault shall have an exterior flange or lugs. The flush mounted protective utility vault shall not extend below the top of the cement/bentonite annular space seal. To prevent damage from frost heave, the concrete surrounding the utility vault shall extend a minimum of 1 foot below the frost line. The flush mounted protective utility vault or the monitoring well shall have a locking mechanism. The monitoring well installed within any flush mounted protective utility vault shall have a watertight cap.

3.3.12 Well Identification

****

NOTE: Local well identification requirements should be specified.

****

A corrosion resistant metal tag shall be affixed to the exterior and interior of the protective cover. The metal tag shall be stamped with the [U.S. Army Corps of Engineers CE [_____]] [_____], well identification number, elevation of the highest point on the rim of the well casing or riser pipe, elevation of the ground surface at the well, well coordinates, date of well installation, and the top of the protective casing elevation in feet as determined according to paragraph SURVEYS. Monitoring wells shall be assigned the identification numbers as indicated on the drawings.

3.3.13 Well Development

****

NOTE: Well development locally improves or restores the aquifer's hydraulic conductivity and removes undesirable materials from the aquifer near the well screen, thus yielding a more representative ground water sample. The most appropriate development method and acceptance criteria to use will vary according to the hydrologic characteristics of the aquifer, the drilling method used and the type of

well completion. The following specification is performance based. The designer may specify a method which has been shown to work well in the project area. In some instances, e.g., very fine-grained sediments, some karst terrains, the well development criteria may not be obtainable. Development criteria should be modified if such conditions are known or suspected to exist. The U.S. Environmental Protection Agency (EPA) may, according to their Technical Enforcement Guidance Document (TEGD), 530/R-93/001, consider a well improperly completed if a well yields turbid samples (turbidity greater than or equal to 5 NTUs) after development. If the local EPA Region enforces this criteria, it may be necessary to include a requirement that the well be developed until a turbidity of less than or equal to 5 NTUs is achieved.
****

Within 7 days of completion of each well, but no sooner than [48] [_____] hours after cement grouting is completed, the well shall be developed. Development shall be performed using only mechanical surging or over pumping or a combination thereof per ASTM D 5521. Details of the proposed development method shall be included in the Monitoring Well Installation Plan. A well development record shall be maintained in accordance with paragraph Well Development Records. Development is complete when:

a. Well water is clear to the unaided eye,

b. Sediment thickness in the well is less than [1 percent of the screen length] [0.1 foot],

c. A minimum of three times the standing water volume in the well plus three times the volume of all added water and drilling fluid lost during drilling and installation of the well is removed, and

d. Temperature, specific conductivity, pH, oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity readings, measured before, twice during and after development operations, have stabilized. Stabilization shall mean [variation of less than 0.2 pH units, variation of $\pm$ 1 degree Fahrenheit,;$\pm$ 3 percent change in specific conductance; $\pm$ 10mV for ORP; and $\pm$ 10 percent for DO, and turbidity, measured between three consecutive readings with one casing volume of water removed between each reading] [_____]. ORP shall be determined in accordance with AWWA EWW. Temperature, specific conductance, DO, turbidity, and pH readings shall be conducted in accordance with EPA 600/4-79/020. At completion of well development, approximately 1 pint of well water shall be collected in a clear glass jar. The jar shall be labeled with project name, well number and date; and photographed using 35 mm color print film. The photograph (minimally 5 x 7 inch) shall be a suitably backlit close-up which shows the clarity of the water and any suspended sediment. The photograph and negative shall become a part of the well development record. Water removed during development and testing operations shall be [contained in D.O.T. approved drums, containers or vessels and disposed of by [_____], in accordance with paragraphs

CONTAINERIZATION OF DEVELOPMENT WATER, AND DRILL CUTTINGS, and Drilling Waste Disposal] [discharged to the ground surface at least [_____] feet from the well in a down gradient area].

3.3.14 In-Situ Permeability Determination

****

NOTE: In some fine grained aquifers, the period of time for the aquifer to reach equilibrium may exceed 24 hours and testing should be performed no sooner than 48 or more hours after the well is developed.

****

The in-situ permeability for each well shall be determined following development and shall occur no sooner than [48] [_____] hours after development. After the well is developed and allowed to equilibrate for at least 24 hours, and before in-situ permeability testing, the static water level in the well shall be measured and recorded. The Contractor shall determine, for each well installed, the in-situ permeability of the screened formation using an appropriate method after the well has been developed. The Contractor shall propose the details of the methods expected to be used and references for those methods in the Monitoring Well Installation Plan. Except for formation water from the well, no other water or liquid shall be introduced into the well.

3.3.15 Drilling Waste Disposal

****

NOTE: The designer must address disposal of drill cuttings, rock core, grout or bentonite slurry, and other solid or liquid materials bailed, pumped, or otherwise removed from the borehole during drilling, well installation, completion, and well development procedures within all appropriate regulatory requirements. The nature of these wastes (whether hazardous or not) will potentially vary between well sites on a single project. On a remedial action project, it may be prudent to dispose of drilling and well installation waste in coordination with other project waste streams. In some instances, rock core may be determined to be contaminated and must be handled accordingly. Refer to EPA/540/G-91/009, Management of Investigation-Derived Waste From Site Investigations and EPA OSWER Directive 9345.3-03FS, April 1992, Guide to Management of Investigation-Derived Wastes, for discussion of some issues relevant to Superfund projects. State/local regulations must also be considered.

****

Slurry, drill cuttings, rock core; other solid or liquid material bailed, pumped, or otherwise removed from the borehole during drilling, installation, completion, and well development procedures; and fluids from material/equipment decontamination activities shall be disposed of by [_____].

3.4 SURVEYS

****
NOTE: Guidance for installing survey markers can be found in EM 1110-1-1002 Survey Markers and Monumentation.
****

Coordinates and elevations shall be established for each monitoring well/test hole. Horizontal coordinates shall be determined to the closest 1.0 foot and referenced to the State Plane Coordinate System, or Universal Transverse Mercator (UTM). If the State Plane Coordinate System/UTM is not readily available, an existing local grid system shall be used. A ground elevation to the closest 0.1 foot shall be obtained at each well. The highest point on the top of the riser pipe will serve as a measurement point. The elevation of the monitoring well shall reference this point, and shall be surveyed to the nearest 0.01 foot using the National Geodetic Vertical Datum of [1929] [1988]. If the datum is not readily available, the existing local vertical datum shall be used. The location, identification, coordinates, and elevations of the well and monuments shall be plotted on maps with a scale large enough to show their location with reference to other structures.

3.5 WELL DECOMMISSIONING/ABANDONMENT

****
NOTE: Guidance for decommissioning of monitoring wells may also be found in EM 1110-1-4000.
****

Any well disapproved by the Contracting Officer, or any well decommissioned/abandoned by the Contractor for any reason shall be decommissioned/abandoned according to the requirements of the State of [_____], ASTM D 5299, and the requirements of these specifications. Well decommissioning/abandonment includes the removal of all materials left in the borehole/well, excluding the filter pack, and including backfill materials, casing, screen, and any other material placed into the hole before the decision was made to abandon the borehole/well. Test holes decommissioned/abandoned for any reason shall be grouted from the bottom to within [_____] feet of the top of the ground surface according to the protocol for grout/bentonite placement established in paragraph Grout Placement, using the grout mix specified in paragraph CEMENT AND BENTONITE GROUT. The top [_____] feet shall be backfilled with [material appropriate for the intended land use] [_____]. The Contractor shall maintain a well decommissioning/abandonment record as specified in paragraph Well Decommissioning/Abandonment Records. Groundwater levels, if encountered before the decision is made for decommissioning/abandonment, shall be measured in all borings prior to backfilling. These water levels shall be included in the well decommissioning/abandonment records. No well shall be decommissioned/abandoned without the approval of the Contracting Officer.

3.6 WELL ACCEPTANCE

It is the responsibility of the Contractor to properly design, construct, install, develop, and test all monitoring wells according to the requirements of this specification so that they are suitable for the intended purpose. If the Contractor installs wells that are not functional or not in accordance with these specifications, the Contracting Officer will disapprove the well and direct the Contractor to repair or replace it, and to abandon the disapproved well in accordance with this specification.

3.7 SITE CLEANUP

After completion of the work, tools, appliances, surplus materials, temporary drainage, rubbish, and debris incidental to work shall be removed. Excavation and vehicular ruts shall be backfilled and dressed to conform with the existing landscape. Utilities, structures, roads, fences, or any other pre-existing item which must be repaired or replaced due to the Contractor's negligence shall be the Contractor's responsibility; repair or replacement shall be accomplished prior to completion of this contract.

3.8 DOCUMENTATION AND QUALITY CONTROL REPORTS

The Contractor shall establish and maintain documentation and quality control reports for well construction and development to record the desired information and to assure compliance with contract requirements, including, but not limited to, the following:

3.8.1 Borehole Logs

****

NOTE: Borehole logging requirements can be found in EM 1110-1-4000, Monitor Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites. Requirements can also be found in ASTM D 2113 and ASTM D 5434. If rock is cored at the site, and it is deemed necessary to determine the rock quality designation (RQD) of the core for design purposes, the RQD should also be shown on the boring log. Guidance for determining the RQD may be found in ASTM D 6032.

****

A borehole log shall be completed for each boring drilled. Borehole logs shall be prepared by the geologist present onsite during all well drilling and installation activities. The log scale shall be [1] [_____] inch equals [1] [_____] foot. Copies of complete well logs shall be kept current in the field at each well site and shall be available at all times for inspection by the Contracting Officer. Information provided on the logs shall include, but not be limited to, the following:

a. Name of the project and site.

b. Boring/well identification number.

c. Location of boring (coordinates, if available).

d. Make and manufacturer's model designation of drilling equipment and name of drilling firm.

e. Date boring was drilled.

f. Reference data for all depth measurements.

g. Name of driller and name and signature of geologist preparing log.

h. Nominal hole diameter and depth at which hole diameter changes.

i. Total depth of boring.

j. Method of drilling, including sampling methods and sample depths, including those attempted with no recovery. Indication of penetration resistance such as drive hammer blows given in blows per 6 inches of driven sample tubes. Information shall include hammer weight and drop distance. Information such as rod size, bit type, pump type, etc., shall be recorded. A description of any temporary casing used, drill fluids and fluid additives used, if any, including brand name and amount used, along with the reason for and start (by depth) of its use shall be included. If measured, mud viscosities and weight shall be recorded.

k. Depth of each change of stratum. If location of strata change is approximate, it shall be so stated.

l. Description of the material of which each stratum is composed, in accordance with [ASTM D 2488] [_____], and/or standard rock nomenclature, as necessary. Soil parameters for logging shall include, but shall not be limited to, classification, depositional environment and formation, if known, Unified Soil Classification Symbol, secondary components and estimated percentages, color (using FSUP Soil Color Chart or GSA RCC-001), plasticity, consistency (cohesive soil), density (non-cohesive soil), moisture content, structure and orientation, and grain angularity. Rock core parameters for logging shall include, but shall not be limited to, rock type, formation, modifier denoting variety (shaly, calcareous, siliceous, etc.), color (using GSA RCC-001), hardness, degree of cementation, texture, crystalline structure and orientation, degree of weathering, solution or void conditions, primary and secondary permeability, and lost core. The results of any chemical field screening shall also be included on the boring log. Classification shall be prepared in the field at the time of sampling. The results of visual observation of the material encountered, and any unusual odor detected shall also be duly noted and recorded.

m. Depth of any observed fractures, weathered zones, or any abnormalities encountered.

n. Depth and estimated percent of drill fluid loss or lost circulation. Measures taken to regain drill water circulation. Significant color changes in the drilling fluid return.

o. Depth to water, and any non-aqueous phase liquids (NAPLs) and date measured before, during, and after each drilling shift, and prior to well installation. The Contractor shall provide and maintain at each well under construction a portable water, and NAPL level measuring device of sufficient length to measure the water/NAPL level to [165] [_____] foot depth. The device shall be available onsite at all times and measuring wire shall be graduated in 0.01 foot. Water and NAPL level measurements shall be taken to the nearest 0.01 foot.

p. Box or sample number. Depths and the number of the core boxes and/or samples shall be recorded at the proper interval.

q. Percent Rock Core Recovery. The percent core recovery for the individual drill runs, if rock is cored, shall be shown.

3.8.2 Installation Diagrams

The well will not be accepted before the geologic logs and installation diagrams are received. The diagram shall illustrate the as-built condition of the well and include, but not be limited to, the following items:

a. Name of the project and site.

b. Well identification number.

c. Name of driller and name and signature of the geologist preparing diagram.

d. Date of well installation.

e. Description of material from which the well is constructed, including well casing/riser pipe and screen material, centralizer composition, if used, diameter and schedule of casing and screen, gradation of filter pack, lithologic description, brand name (if any), source, and processing method, and method of placement of the filter pack, bentonite seal type (pellets, granules, chips, or slurry), grout type (cement or high-solids bentonite) and type of protective cover (protective casing or flush-to-ground).

f. Total depth of well.

g. Nominal hole diameter.

h. Depth to top and bottom of screen, and filter pack.

i. Depth to top and bottom of any seals installed in the well boring (grout or bentonite).

j. Type of cement and/or bentonite used, mix ratios of grout, method of placement and quantities used.

k. Elevations/depths/heights of key features of the well, such as top of well casing/riser pipe, top and bottom of protective casing, ground surface, the depth of maximum frost penetration (frost line), bottom of well screen, top and bottom of filter pack, and top and bottom of seal.

l. Other pertinent construction details, such as slot size and percent open area of screen, type of screen, and manufacturer of screen.

m. Well location by coordinates. A plan sheet shall also be included showing the coordinate system used and the location of each well. A plan sheet is not required for each well installation diagram; multiple wells may be shown on the same sheet.

n. Static water level upon completion of the well.

o. Special problems and their resolutions; e.g., grout in wells, lost casing, or screens, bridging, etc.

p. Description of surface completion.

3.8.3 Well Development Records

A monitoring well development record shall be prepared for each monitoring well installed under the supervision of the geologist present during well installation operations. Information provided on the well development record shall include, but not be limited to, the following:

a. Date, time, and elevation of water level in the well, before development.

b. Depth to bottom of well, name of project and site, well identification number, and date of development.

c. Method used for development, to include size, type and make of equipment, bailer, and/or pump used during development.

d. Time spent developing the well by each method, to include typical pumping rate, if pump is used in development.

e. Volume and physical character of water removed, to include changes during development in clarity, color, particulates, and odor.

f. Volume of water added to the well, if any.

g. Volume and physical character of sediment removed, to include changes during development in color, and odor.

h. Source of any water added to the well.

i. Clarity of water before, during, and after development. Nephelometric turbidity unit (NTU) measurements.

j. Total depth of well and the static water level as per ASTM D 4750 from top of the casing, immediately after pumping/development, and 24 consecutive hours after development.

k. Readings of pH, specific conductance, DO, ORP, and temperature taken before, during, and after development.

l. Name and job title of individual developing well.

m. Name and/or description of the disposal facility/area, for the waters removed during development.

3.8.4 Geophysical Logs

Geophysical logs shall be prepared and completed for each monitoring well/test hole installed. Information provided on the logs shall include, as a minimum, the following:

a. Project name.

b. Test hole/monitoring well identification number.

c. Location of test hole (coordinates, and state, and county name).

d. Date test hole was drilled.

e. Fluid level in test hole before logging.

f. Fluid type and temperature.

g. Fluid resistance in ohm-m.

h. Casing type, diameter, and elevation (top and bottom).

i. Cement type and elevation (top and bottom).

j. Screen type, diameter, and elevation (top and bottom).

k. Date and time test hole was logged.

l. Reference elevation for all depth measurements.

m. Operator's name.

n. Equipment name and address.

o. Logger type and number.

p. Tool type.

q. Detector type (Nuclear Log only).

r. Source type (Nuclear Log only).

s. Source size (Nuclear Log only).

t. Source spacing (Nuclear Log only).

u. Tool length, cable head to detector.

v. Calibration.

w. Logging speed ft/min.

x. Log vert. scale ft/in.

y. Module settings.

z. Recorder settings.

aa. Document all field problems, including equipment malfunctions. This should include the steps taken to solve the problem and how the log might have been affected.

3.8.5 Well Decommissioning/Abandonment Records

Decommissioning/abandonment records shall include, as a minimum, the following:

a. Project name.

b. Well or test hole number.

c. Well/boring location, depth and diameter.

d. Date of decommissioning/abandonment.

e. Method of decommissioning/abandonment.

f. All materials used in the decommissioning/abandonment procedure and the interval in which test materials were placed.

g. Casing, and or other items left in hole by depth, description, and composition.

h. Description and total quantity of grout used initially.

i. Description and daily quantities of grout used to compensate for settlement.

j. Water or mud level (specify) prior to grouting and date measured.

k. The reason for decommissioning/abandonment of the monitoring well/test hole.

3.8.6 Project Photographs

Before, during, and after completion of work, the Contractor shall take a minimum of [one view] [[_____] views] of each well installation. If rock is cored at the site, after the core has been logged the core shall be dampened, if it has dried, neatly arranged in the core box, and photographed. Photographs shall be [3] [_____] x [5] [_____] inch color prints. The photographs shall be mounted and enclosed back-to-back in a double face clear plastic sleeve punched to fit standard three ring binders. Each color print shall show an information box, [1-1/2] [_____] x [3-1/2] [_____] inches. The box shall be typewritten and arranged as follows:

Project No.	Contract No.
Contractor/Photographer:	
Photograph No.	Date/Time:
Description:	
Direction of View:	

3.8.7 Survey Maps and Notes

A tabulated list of all monitoring wells and monuments, copies of all field books, maps showing the locations, and elevations of all monitoring wells, and all computation sheets shall be prepared as a submittal. The tabulation shall consist of the designated number of the well or monument, the X and Y coordinates, and all the required elevations.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02531 (May 1998)**
U.S. ARMY CORPS OF ENGINEERS **----------------------**
Superseding
CEGS-02730 (June 1992)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02531

SANITARY SEWERS
05/98

****
NOTE: This guide specification covers the requirements for sanitary sewers, including pipe and manholes. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for concrete pipe, plastic pipe, reinforced plastic mortar pipe, reinforced thermosetting resin pipe, ductile iron pipe, cast iron soil pipe, and clay pipe. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.
****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN RAILWAY ENGINEERING ASSOCIATION (AREA)

AREA-01	(1996) 1996-1997 Manual for Railway Engineering (Fixed Properties) 4 Vol.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 74	(1996) Cast Iron Soil Pipe and Fittings
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM C 14	(1995) Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 14M	(1995) Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C 33	(1993) Concrete Aggregates
ASTM C 76	(1995a) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 76M	(1996) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 94	(1996) Ready-Mixed Concrete
ASTM C 150	(1997) Portland Cement
ASTM C 260	(1995) Air-Entraining Admixtures for Concrete
ASTM C 270	(1997) Mortar for Unit Masonry
ASTM C 425	(1996) Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443	(1994) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 443M	(1994) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric)
ASTM C 478	(1996) Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(1996) Precast Reinforced Concrete Manhole

Sections (Metric)

ASTM C 564	(1995a) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 700	(1996) Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 828	(1991, R 1996) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C 924	(1989) Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
ASTM C 972	(1995) Compression-Recovery of Tape Sealant
ASTM D 412	(1992) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 624	(1991; R 1996) Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D 1784	(1996) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2680	(1995a)Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
ASTM D 2751	(1996) Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D 2996	(1995) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 2997	(1995) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe
ASTM D 3034	(1994) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3262	(1996) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
ASTM D 3350	(1996) Polyethylene Plastics Pipe and Fittings Materials
ASTM D 3753	(1981; R 1991) Glass-Fiber-Reinforced Polyester Manholes

ASTM D 3840	(1988) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications
ASTM F 402	(1993) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F 477	(1995) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 714	(1994) Polyethylene (PE) Plastic pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(1995a) Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(1995) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F 949	(1994) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA ANSI/AWWA C105/A21.5	(1993) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA ANSI/AWWA C110/A21.10	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA ANSI/AWWA C111/A21.11	(1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA ANSI/AWWA C115/A21.15	(1994) Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
AWWA ANSI/AWWA C151/A21.51	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 49	(1994) Hazardous Chemicals Data
NFPA 325-1	(1994) Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids
NFPA 704	(1996) Identification of the Fire Hazards of Materials for Emergency Response

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1990) Recommended Practice for the Low-Pressure Air Testing of Installed

	Sewer Pipe
UBPPA UNI-B-9	(1990; Addenda 1994) Recommended Performance Specification for Polyvinyl Chloride (PVC) Profile Wall Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter (Nominal Pipe Sizes 4-48 inch)

1.2 GENERAL REQUIREMENTS

The construction required herein shall include appurtenant structures and building sewers to points of connection with the building drains 5 feet outside the building to which the sewer system is to be connected. The Contractor shall replace damaged material and redo unacceptable work at no additional cost to the Government. Excavation and backfilling is specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Backfilling shall be accomplished after inspection by the Contracting Officer. Force mains and inverted siphons are specified in Section 02532 FORCE MAINS AND INVERTED SIPHONS; SEWER. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe shall be stored in accordance with the manufacturer's recommendation and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.3 MEASUREMENT AND PAYMENT

****

NOTE: If a lump-sum contract would be more feasible, this paragraph will be deleted. If a unit-price contract is to be used, the bid items for the unit-price contract will be defined for each unit to be furnished.

****

Measurements and payments will be based on completed work performed in accordance with the drawings, specifications, and the contract payment schedules. No payment will be made under this section for excavation, backfilling, or grading. Payment for such work will be made under Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

1.3.1 Installed Pipe

The length of pipe installed will be measured from center to center of manholes and from the center of sewer to the end of the service connections without deduction for fittings or diameters of manholes and will be paid for according to the applicable contract unit price per foot for the size of pipe. No extra payment will be made for bends.

1.3.2 Manholes

The depth of manholes will be measured from the top of the cover to the invert of the outlet pipe. Manholes will be paid for according to the applicable contract price each for the depth of manhole indicated in the payment schedule. No extra payment will be made for drop manholes except that the concrete used for encasing the drop connection will be measured and paid for according to the contract unit price per cubic yard of concrete for encasement, and no extra payment will be made for pipe fittings required to make connections to manholes.

1.3.3 Concrete

Concrete used for pipe encasement, cradles, and similar supports, indicated or required for reasons other than faulty construction methods or negligence of the Contractor, will be measured and paid for according to the contract unit price for concrete for encasement and cradles.

1.3.4 Connections to Existing Manholes

Connections to existing manholes will be paid for according to the applicable contract unit price per connection for each required size of pipe, which shall be full compensation for all necessary cutting, shaping, pipe fittings, and concrete, except that concrete required for encasing or cradling pipe outside the manhole will be measured and paid for according to the contract unit price for such concrete.

1.3.5 Wye Branches

Wye branches installed in new sewers will be paid for according to the applicable contract unit price for the size indicated in the payment schedule. This will be in addition to the price per foot of straight pipe.

1.3.6 Connections to Existing Sewers

Connections to existing sewers where new wye branches to cut-ins are required will be paid for according to the contract unit price for such connection. The price will be considered as full compensation for material and labor required for the removal and replacement of the pipe as necessary. Excavation, backfill, and concrete connected with such work will be paid for according to the applicable contract unit prices. Connections of this type made to sewers installed under this contract, if ordered after the sewer has been installed, will be paid for as connection to existing sewers.

1.4 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-13 Certificates

Portland Cement; [_____].

Certificates of compliance stating the type of cement used in manufacture of concrete pipe, fittings and precast manholes.

Joints.

Certificates of compliance stating that the fittings or gaskets used for waste drains or lines designated on the plans as [_____] are [oil] [_____] resistant.

PART 2   PRODUCTS

2.1   PIPE

****
NOTE: All pipe materials specified will be retained except under conditions where they would not be suitable; see TM 5-814-1. Where it is determined that a pipe material would be altogether unsuitable, every mention of the unsuitable material and referenced publications that pertain only to the unsuitable material will be deleted. If a material would be suitable in a part of the system and unsuitable in other parts, the locations where the material may and may not be used will be shown on the contract drawings and stated in the contract specifications. A study of the conditions will be made to determine the suitability of the materials. If doubt remains after the study, because of exceptional conditions, a report should be submitted to HQUSACE (CEMP-EG).
****

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1   Concrete Pipe

****
NOTE: Additional information on the selection of concrete sewer pipe is contained in ASCE Manual No. 37 and the "Concrete Pipe Design Manual" of the American Concrete Pipe Association. Reinforced concrete sewer pipe is normally not required when pipe diameters are 600 mm (24 inches) or less, but reinforced concrete pipe in diameters of 300 through 600 mm (12 through 24 inches) may be specified when required for excessive depth of cover or live loads on the pipe.

Tongue and groove type pipe or modified tongue and

groove type pipe may be specified for pipe diameters greater than 600 mm (24 inches) but less than 900 mm (36 inches) when appropriate and available, and when the type of joint will be compatible with the existing concrete sewer pipe on the installation so that excessive repair stockage will not be necessary.
****

Concrete pipe 24 inches or less in diameter, unless otherwise shown or specified, shall be nonreinforced and conform to ASTM C 14, Class [1] [2]. Concrete pipe greater than 24 inches in diameter shall be reinforced and conform to ASTM C 76, Class [_____]. Pipe less than 36 inches in diameter shall be bell and spigot type. Pipe 36 inches or greater in diameter shall be bell and spigot type, tongue and groove type, or modified tongue and groove type.

2.1.2 Plastic Pipe

****
NOTE: Plastic pipe will not be used when it will be subject to temperatures in excess of 43.3 degree C (110 degrees F) or to industrial waste containing organic solvents, strong detergents or other materials that could attack it; unless it has been proven that the particular plastic pipe will not be adversely affected by the waste stream or the ambient environment. Design should follow the UNI-BELL PVC Pipe Association recommendations where applicable.
****

Acrylonitrile-butadiene-styrene (ABS) and polyvinyl chloride (PVC) composite sewer piping shall conform to ASTM D 2680. Size 8 inch through 15 inch diameter.

2.1.2.1 ABS Pipe

ASTM D 2751.

2.1.2.2 PVC Pipe

ASTM D 3034, Type PSM with a maximum SDR of 35, Size 15 inches or less in diameter. ASTM F 949 for corrugated sewer pipes with a smooth interior. UBPPA UNI-B-9 and ASTM F 794, Series 46, for ribbed sewer pipe with smooth interior, size 8 inch through 48 inch diameters. PVC shall be certified by the compounder as meeting the requirements of ASTM D 1784, cell Class 12454B. The pipe stiffness shall be greater than or equal to 735/D for cohesionless material pipe trench backfills.

2.1.2.3 High Density Polyethylene Pipe

ASTM F 894, Class 63, size 18 inch through 120 inch. ASTM F 714, size 4 inch through 48 inch. The polyethylene shall be certified by the resin producer as meeting the requirements of ASTM D 3350, cell Class 334433C. The pipe stiffness shall be greater than or equal to 1170/D for cohesionless material pipe trench backfills.

2.1.3   Reinforced Plastic Mortar Pipe (RPMP)

ASTM D 3262.

2.1.4   Reinforced Thermosetting Resin Pipe (RTRP)

ASTM D 3262.

2.1.4.1   Filament Wound RTRP-I

RTRP-I shall conform to ASTM D 2996, except pipe shall have an outside diameter equal to cast iron outside diameter or standard weight steel pipe. The pipe shall be suitable for a normal working pressure of 150 psi at 73 degrees F.The inner surface of the pipe shall have a smooth uniform continuous resin-rich surface liner conforming to ASTM D 2996.

2.1.4.2   Centrifugally Cast RTRP-II

RTRP-II shall conform to ASTM D 2997. Pipe shall have an outside diameter equal to standard weight steel pipe.

2.1.5   Ductile Iron Pipe

****

NOTE: The use of cast-iron fittings and specials with ductile iron pipe is generally acceptable. However, when required by unusually severe loading conditions, ductile iron fittings and specials conforming to AWWA ANSI/AWWA C110/A21.10 will be specified.

****

Pipe shall conform to AWWA ANSI/AWWA C151/A21.51 unless otherwise shown or specified.

2.1.6   Cast Iron Soil Pipe

****

NOTE: Class XH cast iron will be specified only if required by local conditions. Additional information on selection and installation is contained in "Cast Iron Soil Pipe and Fittings Handbook" of the Cast Iron Soil Pipe Institute. Metallic Pipe laid in reactive soil will be encased in a polyethylene film in accordance with AWWA ANSI/AWWA C105/A21.5.

****

Cast iron soil pipe shall conform to ASTM A 74, Class SV, except where Class XH is indicated. [Lines indicated as acid resistant shall be Class XH and contain not less than 12 percent silicon.] [When installed underground, pipe shall be encased with [_____] mil thick polyethylene in accordance with AWWA ANSI/AWWA C105/A21.5.]

2.1.7   Clay Pipe

****

NOTE: Additional information on selection of clay pipe is contained in ASCE Manual No. 37 and the "Clay Pipe Engineering Manual" of the National Pipe Institute.
****

ASTM C 700 [Extra strength] [Acid resistant, where indicated].

2.2 REQUIREMENTS FOR FITTINGS

Fittings shall be compatible with the pipe supplied and shall have a strength not less than that of the pipe. Fittings shall conform to the respective specifications and other requirements specified below.

2.2.1 Fittings for Concrete Pipe

ASTM C 14 for pipe 24 inches or less in diameter. ASTM C 76 for pipe greater than 24 inches in diameter.

2.2.2 Fittings for Plastic Pipe

ABS and PVC composite sewer pipe fittings shall conform to ASTM D 2680.

2.2.2.1 Fittings for ABS Pipe

ASTM D 2751.

2.2.2.2 Fittings for PVC Pipe

ASTM D 3034 for type PSM pipe. ASTM F 949 for corrugated sewer pipe with a smooth interior. UBPPA UNI-B-9 and ASTM F 794, Series 46, for ribbed sewer pipe with smooth interior.

2.2.2.3 Fittings for High Density Polyethylene Pipe

ASTM F 894.

2.2.3 Fittings for RPMP

ASTM D 3840.

2.2.4 Fittings for RTRP

ASTM D 3262.

2.2.5 Fittings for Ductile Iron Pipe

Mechanical fittings shall conform to AWWA ANSI/AWWA C110/A21.10, rated for 150 psi. Push-on fittings shall conform to AWWA ANSI/AWWA C110/A21.10and AWWA ANSI/AWWA C111/A21.11, rated for 150 psi.

2.2.6 Fittings for Cast Iron Soil Pipe

ASTM A 74.

2.2.7 Fittings for Clay Pipe

ASTM C 700 [Extra strength] [Acid resistant].

2.3 JOINTS

****
NOTE: For industrial sewers, specify gaskets and joints compatible with the waste.
****

Joints installation shall comply with the manufacturer's instructions. Fittings and gaskets utilized for waste drains or industrial waste lines shall be certified by the manufacturer as [oil] [_____] resistant.

2.3.1 Concrete Pipe Jointing

Joints and gaskets shall conform to ASTM C 443.

2.3.2 Plastic Pipe Jointing

Flexible plastic pipe (PVC or high density polyethylene pipe) gasketed joints shall conform to ASTM D 3212.

2.3.2.1 ABS Pipe Jointing

ASTM D 2751, solvent weld or bell and spigot O-ring joint, size 12 inches or less in diameter, dimensions and tolerances in accordance with Table 2 of ASTM D 2751.

2.3.2.2 High Density Polyethylene Pipe Jointing

Rubber gasket joints shall conform to ASTM C 443.

2.3.3 RPMP Jointing

Joints shall be bell and spigot type utilizing an elastomeric gasket in accordance with ASTM F 477.

2.3.4 RTRP Jointing

Joints shall be bell and spigot type utilizing an elastomeric gasket in accordance with ASTM F 477.

2.3.5 Ductile Iron Pipe Jointing

Push-on joints shall conform to AWWA ANSI/AWWA C111/A21.11. Mechanical joints shall conform to AWWA ANSI/AWWA C111/A21.11 as modified by AWWA ANSI/AWWA C151/A21.51. Flanged joints shall conform to AWWA ANSI/AWWA C115/A21.15.

2.3.6 Cast Iron Soil Pipe Jointing

Rubber gaskets for compression joints shall conform to ASTM C 564. Packing material for caulked joints shall be twisted jute or oakum, tarred type, or asphalt-saturated cellulose-fiber. Joints for acid resisting cast iron soil pipe shall be made with acid resistant non-asbestos packing. The packing shall not contain material which would affect adhesion of the joint sealing material to the pipe. Lead shall be suitable for caulking of joints.

2.3.7 Clay Pipe Jointing

Compression joints shall conform to ASTM C 425.

2.4 BRANCH CONNECTIONS

Branch connections shall be made by use of regular fittings or solvent cemented saddles as approved. Saddles for ABS and PVC composite pipe shall conform to Figure 2 of ASTM D 2680; saddles for ABS pipe shall comply with Table 3 of ASTM D 2751; and saddles for PVC pipe shall conform to Table 4 of ASTM D 3034.

2.5 FRAMES AND COVERS

Frames and covers shall be cast iron, ductile iron or reinforced concrete. Cast iron frames and covers shall be as indicated or shall be of type suitable for the application, circular, without vent holes. The frames and covers shall have a combined weight of not less than 400 pounds. Reinforced concrete frames and covers shall be as indicated or shall conform to ASTM C 478 or ASTM C 478M. The word "Sewer" shall be stamped or cast into covers so that it is plainly visible.

2.6 STEEL LADDER

A steel ladder shall be provided where the depth of a manhole exceeds 12 feet. The ladder shall not be less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers shall be a minimum 3/8 inch thick and 2 inches wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123.

2.7 CEMENT MORTAR

Cement mortar shall conform to ASTM C 270, Type M with Type II cement.

2.7.1 Portland Cement

****

NOTE: Type II cement normally will be specified, but Type V cement will be specified when the soils contain in excess of 0.2 percent water-soluble sulfate as SO(4), or the waste water contains in excess of 1000 parts per million sulfates. Type I cement may be permitted when it can be assured that the water soluble sulfates in the soil will be less than 0.1 percent and the waste water will contain less than 150 parts per million sulfates over the design life of the project.

****

Portland cement shall conform to ASTM C 150, Type [II] [V] for concrete used in concrete pipe, concrete pipe fittings, and manholes and type optional with the Contractor for cement used in concrete cradle, concrete encasement, and thrust blocking. [Air-entraining admixture conforming to ASTM C 260 shall be used with Type V cement.] [Where aggregates are alkali reactive, as determined by Appendix XI of ASTM C 33, a cement containing less than 0.60 percent alkalies shall be used.]

2.7.2 Portland Cement Concrete

****

NOTE: When ready-mix concrete conforming to ASTM C 94 is not economically available, rewrite this paragraph to permit use of concrete mixed onsite. Specify concrete aggregates conforming to ASTM C 33 and concrete consisting of 1 part portland cement, 2-1/2 parts sand, and 5 parts gravel, with just enough water for workable consistency.
****

Portland cement concrete shall conform to ASTM C 94, compressive strength of 4000 psi at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement shall have a compressive strength of 2500 psiminimum at 28 days. Concrete in place shall be protected from freezing and moisture loss for 7 days.

2.8   STRUCTURES

2.8.1   Precast Reinforced Concrete Manhole Sections

Precast reinforced concrete manhole sections shall conform to ASTM C 478, except that portland cement shall be as specified herein. Joints shall be cement mortar, an approved mastic, rubber gaskets, a combination of these types; or the use of external preformed rubber joint seals and extruded rolls of rubber with mastic adhesive on one side.

2.8.2   Glass-Fiber-Reinforced Polyester Manholes

Glass-fiber-reinforced polyester manholes shall conform to ASTM D 3753.

PART 3   EXECUTION

3.1   INSTALLATION

****
NOTE: Where the sewer is to be laid near the route of an existing water pipe, the in-place location of the water pipe will be checked before laying the sewer, and will be shown on the contract drawings. The design engineer must evaluate the conditions of hazard for sewer and adjacent structures, traffic ways, and paved areas peculiar to each installation and determine sleeve requirements and length. When the option for flexible material for sewer pipe is permitted and use of such would require additional pipe sleeves, such locations will also be noted in the contract documents. When pipeline locations would subject the installed pipe to temperatures in excess of 43.3 degrees C (110 degrees F), the contract documents should annotate that use of plastic pipe in these locations will require the new pipe to be insulated, unless the particular plastic pipe has been proven not to be adversely affected by the higher temperature.
****

3.1.1   Adjacent Facilities

3.1.1.1 Water Lines

Where the location of the sewer is not clearly defined by dimensions on the drawings, the sewer shall not be closer horizontally than 10 feet to a water-supply main or service line, except that where the bottom of the water pipe will be at least 12 inches above the top of the sewer pipe, the horizontal spacing may be a minimum of 6 feet. Where gravity-flow sewers cross above water lines, the sewer pipe for a distance of 10 feet on each side of the crossing shall be fully encased in concrete or shall be acceptable pressure pipe with no joint closer horizontally than 3 feet to the crossing. The thickness of the concrete encasement including that at the pipe joints shall be not less than 4 inches.

3.1.1.2 Roads, Railroads, and Airfields

****

NOTE: The first blank in the paragraph should have the name of the railway company having jurisdiction inserted where applicable.

****

Water pipe shall be encased in a sleeve of rigid conduit for the lengths shown. Sleeves under railroads shall be in accordance with [the [_____] railroad company requirements] [the criteria contained in AREA-01, Part 5]. Where sleeves are required, in all other cases, the pipe sleeve shall be as specified for storm drains in Section 02630 STORM-DRAINAGE SYSTEM. A minimum clearance of at least 2 inches between the inner wall of the sleeve and the maximum outside diameter of the sleeved pipe and joints shall be provided. Sand bedding shall be provided for the water pipe through the sleeve. Sleeves of ferrous material shall be provided with the corrosion protection as required for the conditions encountered at the site of installation.

3.1.1.3 Structural Foundations

Where sewer pipe is to be installed within 3 feet of an existing or proposed building or structural foundation such as a retaining wall, control tower footing, water tank footing, or any similar structure, the sewer pipe shall be sleeved as specified above. Contractor shall ensure there is no damage to these structures, and no settlement or movement of foundations or footing.

3.1.2 Pipe Laying

a. Pipe shall be protected during handling against impact shocks and free fall; the pipe interior shall be free of extraneous material.

b. Pipe laying shall proceed upgrade with the spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow. Each pipe shall be laid accurately to the line and grade shown on the drawings. Pipe shall be laid and centered so that the sewer has a uniform invert. As the work progresses, the interior of the sewer shall be cleared of all superfluous materials.

c. Before making pipe joints, all surfaces of the portions of the pipe to be joined shall be clean and dry. Lubricants, primers, and adhesives shall be used as recommended by the pipe manufacturer. The joints shall then be placed, fitted, joined, and adjusted to obtain the degree of water tightness required.

d. ABS composite pipe ends with exposed truss and filler material shall be coated with solvent weld material before making the joint to prevent water or air passage at the joint between the inner and outer wall of the pipe.

e. Installations of solvent weld joint pipe, using ABS or PVC pipe and fittings shall be in accordance with ASTM F 402. The Contractor shall ensure adequate trench ventilation and protection for workers installing the pipe.

3.1.2.1 Caulked Joints

The packing material shall be well packed into the annular space to prevent the entrance of lead into the pipe. The remainder of the space shall be filled with molten lead that is hot enough to show a rapid change in color when stirred. Scum shall be removed before pouring. The lead shall be caulked to form a tight joint without overstraining the bell and shall have a minimum depth of 1 inch after caulking.

3.1.2.2 Trenches

Trenches shall be kept free of water and as dry as possible during bedding, laying, and jointing and for as long a period as required. When work is not in progress, open ends of pipe and fittings shall be satisfactorily closed so that no trench water or other material will enter the pipe or fittings.

3.1.2.3 Backfill

As soon as possible after the joint is made, sufficient backfill material shall be placed along the pipe to prevent pipe movement off line or grade. Plastic pipe shall be completely covered to prevent damage from ultraviolet light.

3.1.2.4 Width of Trench

If the maximum width of the trench at the top of the pipe, as specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, is exceeded for any reason other than by direction, the Contractor shall install, at no additional cost to the Government, concrete cradling, pipe encasement, or other bedding required to support the added load of the backfill.

3.1.2.5 Jointing

Joints between different pipe materials shall be made as specified, using approved jointing materials.

3.1.2.6 Handling and Storage

Pipe, fittings and joint material shall be handled and stored in accordance with the manufacturer's recommendations. Storage facilities for plastic pipe, fittings, joint materials and solvents shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325-1.

3.1.3 Leakage Tests

Lines shall be tested for leakage by low pressure air testing, infiltration tests or exfiltration tests, as appropriate. Low pressure air testing for vitrified clay pipes shall be as prescribed in ASTM C 828. Low pressure air testing for concrete pipes shall be as prescribed in ASTM C 828. Low pressure air testing for PVC pipe shall be as prescribed in UBPPA UNI-B-6. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C 828 and ASTM C 924, after consultation with the pipe manufacturer. Prior to infiltration or exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. When the Contracting Officer determines that infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be re-established. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed [250 gal per inch diameter per mile of pipeline per day] [0.2 gal per inch diameter per 100 feet of pipeline per hour]. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Government.

3.1.4 Test for Deflection

When flexible pipe is used, a deflection test shall be made on the entire length of the installed pipeline not less than 30 days after the completion of all work including the leakage test, backfill, and placement of any fill, grading, paving, concrete, or superimposed loads. Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. The ball, cylinder, or circular sections shall have a diameter, or minor diameter as applicable, of 92.5 percent of the inside diameter of the pipe, but 95 percent for RPMP and RTRP. A tolerance of plus 0.5 percent will be permitted. The ball, cylinder, or circular sections shall be of a homogeneous material throughout, shall have a density greater than 1.0 as related to water at 39.2 degrees F, and shall have a surface brinell hardness of not less than 150. The device shall be center bored and through bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of 70,000 psi or more, with eyes at each end for attaching pulling cables. The eye shall be suitably backed with flange or heavy washer; a pull exerted on the opposite end of the shaft shall produce compression throughout the remote end of the ball, cylinder or circular section. Circular sections shall be spaced so that the distance from the external faces of the front and back sections shall equal or exceed the diameter of the circular section. Failure of the ball, cylinder, or circular section to pass freely through a pipe run, either by being pulled through or by being flushed through with water, shall be cause for rejection of that run. When a deflection device is used for the test in lieu of the ball, cylinder, or circular sections described, such device shall be approved prior to use. The device shall be sensitive to 1.0 percent of the diameter of the pipe being measured and shall be accurate to 1.0 percent of the indicated dimension. Installed pipe showing deflections greater than 7.5 percent of the normal diameter of the pipe, or 5 percent for RTRP and RPMP, shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced at no cost to the Government.

3.2 CONCRETE CRADLE AND ENCASEMENT

The pipe shall be supported on a concrete cradle, or encased in concrete where indicated or directed.

3.3 INSTALLATION OF WYE BRANCHES

Wye branches shall be installed where sewer connections are indicated or where directed. Cutting into piping for connections shall not be done except in special approved cases. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, the pipe shall be encased in concrete backfill or supported on a concrete cradle as directed. Concrete required because of conditions resulting from faulty construction methods or negligence by the Contractor shall be installed at no additional cost to the Government. The installation of wye branches in an existing sewer shall be made by a method which does not damage the integrity of the existing sewer. One acceptable method consists of removing one pipe section, breaking off the upper half of the bell of the next lower section and half of the running bell of wye section. After placing the new section, it shall be rotated so that the broken half of the bell will be at the bottom. The two joints shall then be made with joint packing and cement mortar.

3.4 MANHOLE DETAILS

****

NOTE: Project drawings will include HQUSACE Standard Drawing No. 40-08-02 or a drawing incorporating the principal construction features and safety features shown thereon.

****

3.4.1 General Requirements

Manholes shall be constructed of glass-fiber-reinforced polyester, prefabricated plastic, concrete, or precast concrete manhole sections. The invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly. The invert channels shall be formed directly in the concrete of the manhole base, or shall be built up with brick and mortar, or shall be half tile laid in concrete, or shall be constructed by laying full section sewer pipe through the manhole and breaking out the top half after the surrounding concrete has hardened. Pipe connections shall be made to manhole using water stops, standard O-ring joints, special manhole coupling, or shall be made in accordance with the manufacturer's recommendation. The Contractor's proposed method of connection, list of materials selected, and specials required, shall be approved prior to installation. The floor of the manhole outside the channels shall be smooth and shall slope toward the channels not less than 1 inch per foot nor more than 2 inches per foot. Free drop inside the manholes shall not exceed 18 inches, measured from the invert of the inlet pipe to the top of the floor of the manhole outside the channels; drop manholes shall be constructed whenever the free drop would otherwise be greater than 1 foot 6 inches.

3.4.2 Steel Ladder Anchorage

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet apart vertically, and shall be installed to provide at least 6 inches of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

3.4.3 Jointing, Plastering and Sealing

Mortar joints shall be completely filled and shall be smooth and free from surplus mortar on the inside of the manhole. Mortar and mastic joints between precast rings shall be full-bedded in jointing compound and shall be smoothed to a uniform surface on both the interior and exterior of the manhole. Installation of rubber gasket joints between precast rings shall be in accordance with the recommendations of the manufacturer. Precast rings may also be sealed by the use of extruded rolls of rubber with mastic adhesive on one side.

3.4.4 Setting of Frames and Covers

Unless otherwise indicated, tops of frames and covers shall be set flush with finished grade in paved areas or 2 inches higher than finished grade in unpaved areas. Frame and cover assemblies shall be sealed to manhole sections using external preformed rubber joint seals that meet the requirements of ASTM D 412 and ASTM D 624, or other methods specified in paragraph Jointing, Plastering and Sealing, unless otherwise specified.

3.4.5 External Preformed Rubber Joint Seals

External preformed rubber joint seals and extruded rolls of rubber with mastic adhesive shall meet the requirements of ASTM D 412 and ASTM C 972 to ensure conformance with paragraph Leakage Tests. The seal shall be multi-section with neoprene rubber top section and all lower sections made of Ethylene Propylene Di Monomer (EPDM) rubber with a minimum thickness of 60 mils. Each unit shall consist of a top and a bottom section and shall have mastic on the bottom of the bottom section and mastic on the top and bottom of the top section. The mastic shall be non-hardening butyl rubber sealant and shall seal to the cone/top slab of the manhole/catch basin and over the lip of the casting. One unit shall seal a casting and up to six, 2 inch adjusting rings. The bottom section shall be 12 inches in height. A 6 inch high top section will cover up to two, 2 inchadjusting rings. A 12 inch high bottom section will cover up to six, 2 inch adjusting rings. Extension sections shall cover up to two more adjusting rings. Each extension shall overlap the bottom section by 2 inches and shall be overlapped by the top section by 2 inches.

3.5 CONNECTING TO EXISTING MANHOLES

Pipe connections to existing manholes shall be made so that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. The connection shall be centered on the manhole. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

3.6 BUILDING CONNECTIONS

Building connections shall include the lines to and connection with the building waste drainage piping at a point approximately 5 feet outside the building, unless otherwise indicated. Where building drain piping is not installed, the Contractor shall terminate the building connections approximately 5 feet from the site of the building at a point and in a manner designated.

3.7 CLEANOUTS AND OTHER APPURTENANCES

Cleanouts and other appurtenances shall be installed where shown on the drawings or as directed by the Contracting Officer, and shall conform to the detail of the drawings.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02532 (July 1998)**
U.S. ARMY CORPS OF ENGINEERS **----------------------**
Superseding
CEGS-02732 (June 1992)

GUIDE SPECIFICATION FOR CONSTRUCTION

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02532

FORCE MAINS AND INVERTED SIPHONS; SEWER
07/98

****
NOTE: This guide specification covers the requirements for force mains and inverted siphons for sewage systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: See TM 5-814-2 for additional design information on force mains and inverted siphons.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic

designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 6D	(1994; Supple 1 Jun 1996; Supple 2 Dec 1997) Pipeline Valves (Gate, Plug, Ball, and Check Valves)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1997) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM C 478	(1996) Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(1996) Precast Reinforced Concrete Manhole Sections (Metric)
ASTM D 1784	(1996) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(1996a) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2122	(1995) Determining Dimensions of Thermoplastic Pipe and Fittings
ASTM D 2241	(1996a) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(1996a) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2657	(1996) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D 2774	(1994) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2996	(1995) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 3035	(1995) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D 3139	(1996a) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3308	(1991a) PTFE Resin Skived Tape
ASTM D 3350	(1996) Polyethylene Plastics Pipe and Fittings Materials

ASTM D 3517	(1996) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe
ASTM D 4101	(1996a) Propylene Plastic Injection and Extrusion Materials
ASTM F 477	(1995) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 1483	(1993) Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA ANSI/AWWA C105/A21.5	(1993) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA ANSI/AWWA C110/A21.10	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA ANSI/AWWA C111/A21.11	(1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA ANSI/AWWA C115/A21.15	(1994) Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
AWWA ANSI/AWWA C151/A21.51	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C200	(1991) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(1991) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C207	(1994) Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
AWWA ANSI/AWWA C208	(1996) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C210	(1992) Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C300	(1989) Reinforced Concrete Pressure Pipe,

Steel-Cylinder Type, for Water and Other Liquids

AWWA C301	(1992) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids
AWWA ANSI/AWWA C303	(1995) Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
AWWA C500	(1993; C500a) Metal-Seated Gate Valves for Water Supply Service
AWWA ANSI/AWWA C508	(1993; C508a) Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS
AWWA C600	(1993) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C900	(1989; C900a) Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

DIPRA-01	(1997) Thrust Restraint Design for Ductile Iron Pipe

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-78	(1987; R 1992) Cast Iron Plug Valves, Flanged and Threaded Ends

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-09 Reports

Hydrostatic Tests; [_____].

Copies of test results.

1.3 DELIVERY AND STORAGE

Pipe, fittings and accessories, and pipe coatings shall not be damaged during delivery, handling, and storage.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

****

NOTE: No type of pipe specified in this section will be deleted except:

a. As described throughout these notes.

b. Upon specific approval of HQUSACE (CEMP-ET).

c. As stipulated in specific directives.

d. When a certain type is required by a railroad company for piping passing under its right-of-way.

Generally, force mains less than 100 mm (4 inches) in diameter will not be recommended; however, circumstances may require smaller force mains; in those cases, cutter pumps or other shredding devices will be required.

Class 150 pipe will normally be specified for force mains and inverted siphons except where local conditions require a higher class. Class 150 pipe is furnished with wall thickness suitable for laying with a standard design depth of cover, using a flat-bottom trench without blocks and with compacted backfill. For other conditions, the class or pressure, and loading will be specified accordingly. See TM 5-813-5 for additional criteria and requirements regarding pipe. Cast-iron fittings can be used with most of the pipe materials specified. Flanged joints will not be used for buried installation because a flanged joint requires special construction considerations when buried.

****

Piping for force mains less than 4 inches in diameter shall be galvanized steel, polyvinyl chloride (PVC) plastic, polyethylene (PE) plastic or polypropylene plastic. Piping less than 4 inches in diameter inside pump stations shall be galvanized steel. Piping for [force mains] [and] [inverted siphons] 4 inches in diameter and larger shall be ductile iron, steel, concrete pressure pipe, PVC plastic, Oriented PVC PE plastic, or reinforced thermosetting resin pipe (RTRP). Piping 8 inches in diameter and larger may also be reinforced plastic mortar pressure (RPMP) pipe. Piping 4 inches in diameter and larger inside pump stations shall be ductile iron pipe with bolted flange joints. Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 Concrete Pressure Pipe

****

NOTE: Use reinforced and prestressed concrete pipe for water supply distribution lines. AWWA Standards do not include sizes less than 254 mm (10 inches) in diameter. Applicable size ranges for publications referenced in this paragraph are as follows:

Publication	**mm**	**(Inches)**
AWWA ANSI/AWWA C303 (Reinforced)	**250 - 1050**	**(10-42)**
AWWA C300 (Reinforced)	**600 - 3600**	**(24-144)**
AWWA C301 (Prestressed)	**400 - 3600**	**(16-144)**

In localities where 150 and 200 mm (6-and 8-inch) pipe conforming to AWWA ANSI/AWWA C303 is available, the following will be included in the contract specification as appropriate. In addition to the data in TABLE 1 of AWWA ANSI/AWWA C303, the following shall be applicable:

Nominal inside diameter of pipe,	**mm (inches**	**150 6**	**200 8)**
Nominal lining thickness,	**mm (inch**	**6 1/4**	**6 1/4)**
Nominal coating thickness,	**mm (inch**	**25.4 1**	**25.4 1)**
Class 150			
Total steel area per mm, square mm (per foot, square inch		**1990 0.94**	**1990 0.94)**
Gauge cylinder number		**16**	**16**

****

Concrete pressure pipe and fittings shall conform to [AWWA C300], [AWWA C301], [or] [AWWA ANSI/AWWA C303], as applicable for the service requirements, with rubber gasket joints of the type using steel bell and spigot joint rings.

2.1.2 Plastic Pipe

2.1.2.1 PE Pipe

ASTM D 3350 and ASTM D 3035, minimum pressure rating of 100 psi at 73.4

degrees F.

2.1.2.2 Polypropylene Pipe

ASTM D 2122 and ASTM D 4101.

2.1.2.3 PVC Pipe

****

NOTE: ASTM D 1785 will be used for threaded joints. The SDR (Pressure rating) system and PC (Pressure class) system are not directly related. Reference should be made to the pertinent standards for clarification. Pressure rated plastic pipe should be derated because water hammer and surges are not included in the design. It is suggested that the operating pressure not exceed 2/3 of the rated working pressure. Pressure class plastic pipe, meeting AWWA C900 standards, will not require a derating for instantaneous velocity change not exceeding 0.61 meters per second (2 fps) and for temperature range not exceeding 23 degrees C (72 degrees F).

****

a. PVC Pipe and Fittings Less Than 4 inches Diameter: ASTM D 1785, Schedule [40] [80] [120], or ASTM D 2241, SDR [21] [26] [32.5], with screw joints, push-on joints, or solvent weld joints.

b. PVC Pipe and Fittings 4 inches Diameter and Larger: ASTM D 2241, SDR [21] [26] [32.5], or AWWA C900, Class [100] [150] [200], with push-on joints.

2.1.2.4 Oriented Polyvinyl Chloride (PVCO) Plastic Pipe

Pipe, couplings, and fittings shall be manufactured of material conforming to ASTM D 1784, Class 1245B. Pipe shall conform to AWWA C900, Class 150, and to ASTM F 1483 and shall have an outside diameter equal to cast iron outside diameter.

2.1.3 RPMP Pipe

ASTM D 3517. Fittings shall be compatible with the pipe supplied and shall be suitable for working and testing pressures specified for the pipe.

2.1.4 RTRP Lines

ASTM D 2996, 350 psi rated, cast iron pipe dimensions only, with elastomeric gasket joints. Fittings: AWWA ANSI/AWWA C110/A21.10, rated 150 psi. When mechanical joint fittings are used, inside sleeves provided by the manufacturer shall be used.

2.1.5 Ductile Iron Pipe

****

NOTE: The use of cast-iron fittings and specials with ductile iron pipe is generally acceptable. However, when required by unusually severe loading

conditions, ductile iron fittings and specials conforming to AWWA ANSI/AWWA C110/A21.10 will be specified.
****

a. Ductile Iron Pipe: AWWA ANSI/AWWA C151/A21.51, working pressure not less than 150 psi, unless otherwise shown or specified.

b. River Crossing Pipe: AWWA ANSI/AWWA C151/A21.51, minimum thickness Class 54 with joints in compliance with applicable requirements of AWWA ANSI/AWWA C110/A21.10.

c. Fittings, Mechanical: AWWA ANSI/AWWA C110/A21.10, rated for 150 psi.

d. Fittings, Push-On: AWWA ANSI/AWWA C110/A21.10 and AWWA ANSI/AWWA C111/A21.11, rated for 150 psi.

2.1.6 Steel Pipe

a. Steel Pipe, 6 inches Diameter and Larger: AWWA C200.

b. Steel Pipe Less Than 6 inches Diameter: ASTM A 53, standard weight, threaded end, galvanized.

c. Fittings, 6 inches Diameter and Larger: AWWA C200, fabricated in compliance with AWWA ANSI/AWWA C208.

d. Fittings Less Than 6 inches Diameter: ASME B16.3, galvanized.

2.2 JOINTS

2.2.1 PE Piping

a. Heat Fusion Joints: ASTM D 2657.

b. Flanged Joints: ASME B16.1 or AWWA C207.

c. Mechanical Joints: ASME B16.1.

2.2.2 Polypropylene Piping

Heat Fusion Joints: ASTM D 2657.

2.2.3 PVC Piping

a. Screw Joint Fittings: ASTM D 2464, Schedule 80.

b. Push-On Joint Fittings: ASTM D 3139, with ASTM F 477gaskets.

c. Solvent Cement: ASTM D 2564.

d. Couplings for use with plain end pipe shall have centering rings or stops to ensure the coupling is centered on the joint.

2.2.4 PVCO Pipe

Joints shall conform to ASTM D 3139. Elastomeric gaskets shall conform to ASTM F 477.

2.2.5 Ductile Iron Piping

a. Push-on Joints: AWWA ANSI/AWWA C111/A21.11.

b. Mechanical Joints: AWWA ANSI/AWWA C111/A21.11 as modified by AWWA ANSI/AWWA C151/A21.51.

c. Flanged Joints: AWWA ANSI/AWWA C115/A21.15.

2.2.6 Steel Piping

a. Push-on Joints: AWWA C200.

b. Mechanical Joints: AWWA C200.

c. Flanged Joints: AWWA C207.

2.3 VALVES

2.3.1 Gate Valves

Gate valves 3 inches and larger shall comply with AWWA C500. Valves for buried service shall be non-rising stem (NRS), 2 inch square nut operated with joints applicable to the pipe or installation. Buried valves shall be furnished with extension stems comprising socket, extension stem and operating nut, and shall be of an appropriate length to bring operating nut to within 6 inches of grade. One 4 foot "T" handle valve wrench shall be furnished for each quantity of 6 buried valves. Gate valves that are exposed or installed inside shall be outside screw and yoke (OS&Y), handwheel operated with flange ends unless otherwise indicated. Gate valve operating nuts and handwheels shall have an arrow and the word "OPEN" cast in raised letters to indicate the direction of opening. Gate valves 14 inches and larger shall be equipped with gearing to reduce operating effort. Gate valves 14 inches and larger installed in horizontal lines in horizontal position with stems horizontal shall be equipped with bronze track, roller and scrapers to support the weight of the gate for its full length of travel. Gate valves 14 inches and larger installed in vertical pipe lines with stems horizontal shall be fitted with slides to assist the travel of the gate assembly.

2.3.2 Check Valves

****

NOTE: When the design requires the use of check valves with outside balance levers, an appropriate descriptive statement will be added. Several types of swing check valves are available for several different job requirements and the manufacturer should be consulted for specific job applications. These valves include horizontal, lever and weight, lever and spring, air cushion, oil hydraulic, etc. The operating pressure and force main velocity will determine the type of swing check valve needed.

****

Check valves shall permit free flow of sewage forward and provide a positive check against backflow. Check valves shall be designed for a minimum working pressure of 150 psi or as indicated. The body shall be iron. The manufacturer's name, initials, or trademark and also the size of the valve, working pressure, and direction of flow shall be directly cast on the body.

a. Ball Check Valves shall be iron body, shall have flanged ends, and shall be the non-slam type. Flanges shall be the 125 pound type complying with ASME B16.1. Ball shall be stainless steel unless otherwise specified.

b. Swing Check Valves shall comply with AWWA ANSI/AWWA C508 and shall be iron body, bronze mounted, and shall have flanged ends. Flanges shall be the 125 pound type complying with ASME B16.1.

2.3.3 Plug Valves

Cast iron valves shall comply with MSS SP-78. Steel plug valves shall comply with API Spec 6D.

2.3.4 Pinch Valves

Pinch valves shall be double acting, jam-proof type with unobstructed streamlined flows and built-in operator. The body shall be iron with a non-rising handwheel. The sleeve shall be of pure gum rubber, neoprene, Buna N or hypalon as required for service. The valve shall have flanged ends. Flanges shall be of the 125 pound type complying with ASME B16.1.

2.3.5 Air Release Valves

****

NOTE: When conditions indicate that vacuum conditions may exist in the line, the use of a sewage air and vacuum valve may be required. An appropriate paragraph will be added. Air vents will be specifically adapted for use with sewage.

****

Air release valves shall be designed to permit release of air from an empty pipe during filling and shall be capable of discharging accumulated air in the line while the line is in operation and under pressure. Valves shall be attached by means of threaded pipe connections. Valves shall be vented to the atmosphere.

a. Manual Air Release Valves: Manual air release valves shall consist of a 3 inch gate valve and 3 inch ductile iron pipe and fittings. The valve shall be installed with its line of flow in the horizontal position.

b. Automatic Air Release Valve: Automatic air release valves shall be of the compound lever type capable of withstanding operating pressures of 150 psi. The valves shall have a 1/2 inch outlet. The body and cover of the valve shall be of iron with a stainless steel float. All internal parts shall be stainless steel or bronze. The valve shall be specifically adapted for use with sewage. Each valve shall be complete with hose and blow-off valves to permit backflushing without dismantling the valve.

2.4 VALVE BOXES

Valve boxes shall be cast iron or concrete, except that concrete boxes may be installed only in locations not subject to vehicular traffic. Cast iron boxes shall be the extension type with slide type adjustment and with flared base. The minimum thickness of metal shall be 3/16 inch. The box length shall be adaptable, without full extension, to the depth of cover over the pipe at the valve locations. Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment. The word "SEWER" shall be cast in the cover.

2.5 VALVE VAULTS

****

NOTE: Valve vaults will be required on all air vents installed on the buried force mains. Details will be shown on the drawings. When valve vaults are not required, this paragraph will be deleted.

****

Valve vaults shall be precast concrete units conforming to ASTM C 478.

2.6 MISCELLANEOUS MATERIALS

Miscellaneous materials shall comply with the following requirements:

2.6.1 Pipe Coatings and Linings

****

NOTE: TM 5-814-1/AFM 88-11, Vol. 1 includes conditions requiring lining and coating of pipes. Protective materials for galvanized pipe less than 80 mm (3 inches) in diameter will be required only where the pipe is within the zone of influence of adjacent buried cathodic protection systems.

****

a. Steel, interior: AWWA C203 or AWWA C210.

b. Steel, exterior, buried: AWWA C203.

c. Steel, exterior, exposed: AWWA C210.

2.6.2 Joint Lubricants

Joint lubricants shall be as recommended by the pipe manufacturer.

2.6.3 Bolts, Nuts and Glands

AWWA ANSI/AWWA C111/A21.11.

2.6.4 Joint Compound

A stiff mixture of graphite and oil or inert filler and oil.

2.6.5 Joint Tape

ASTM D 3308.

2.6.6 Bond Wire

Bond wire type RHW or USE, Size 1/0 AWG, neoprene jacketed copper conductor shaped to stand clear of the joint.

PART 3 EXECUTION

3.1 INSTALLATION

Pipe, pipe fittings, and appurtenances shall be installed at the locations indicated. Excavation, trenching, and backfilling shall be as specified in Section 02316 EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES SYSTEMS.

3.1.1 Adjacent Facilities

Installation of force mains and inverted siphons near adjacent facilities shall be as specified in Section 02531 SANITARY SEWERS.

3.1.2 Cutting

Pipe shall be cut in a neat manner with mechanical cutters. Wheel cutters shall be used where practicable. Sharp and rough edges shall be ground smooth and loose material removed from the pipe before laying.

3.1.3 Laying

Except where otherwise authorized, pipe shall be laid with bells facing the direction of laying. Before lowering and while suspended, the pipe shall be inspected for defects. Defective material shall be rejected. Pipe shall be laid in compliance with the following:

a. Ductile Iron: AWWA C600.

b. Steel: AWWA C600.

c. Concrete: Manufacturer's instructions.

d. Polyvinyl Chloride: Manufacturer's instructions.

e. Polyethylene: ASTM D 2774.

f. Polypropylene: ASTM D 2774.

g. Reinforced Thermosetting Resin: Manufacturer's instructions.

h. Reinforced Plastic Mortar: Manufacturer's Instructions.

3.1.4 Jointing

3.1.4.1 Concrete Pressure Pipe

The manufacturer's instructions shall be followed when lubricating and installing rubber gaskets. Joints shall comply with the manufacturer's instructions. The external annular space shall be filled with cement mortar or with a portland cement-filled polyurethane loop. For pipe 24 inch diameter and larger, the internal annular space shall be filled with cement mortar and struck off to ensure a smooth and continuous surface between pipe sections. Pipe less than 24 inch diameter shall have a rope or trowelable mastic affixed to the concrete face of the bell socket before joining the sections of pipe. The mastic shall not be detrimental to the rubber gasket and shall fill the interior annular space when the pipe sections are pushed together.

3.1.4.2 Joints for PE Pipe

Heat fusion joints shall comply with the manufacturer's instructions concerning equipment, temperature, melt time, heat coat, and joining time. Flanged and mechanical joints shall be made in compliance with the manufacturer's instructions.

3.1.4.3 Joints for Polypropylene Pipe

Heat fusion joints shall comply with the manufacturer's instructions concerning equipment, temperature, melt time, heat coat, and joining time.

3.1.4.4 Joints for PVC Pipe

a. Threaded joints shall be made by wrapping the male threads with joint tape or by applying an approved thread lubricant, then threading the joining members together. The joint shall be tightened with strap wrenches which will not damage the pipe and fittings. The joint shall be tightened no more than 2 threads past hand-tight.

b. Push-on joints: The ends of pipe for push-on joints shall be beveled to facilitate assembly. Pipe shall be marked to indicate when the pipe is fully seated. The gasket shall be lubricated to prevent displacement. The gasket shall remain in proper position in the bell or coupling while the joint is made.

c. Solvent-weld joints shall comply with the manufacturer's instructions.

3.1.4.5 Joints for RPMP Pipe

Elastomeric gasket joints shall comply with the manufacturer's instructions.

3.1.4.6 Joints for RTRP Lines

Elastomeric gasket joints shall comply with the manufacturer's instructions.

3.1.4.7 Joints for Ductile Iron Pipe

Installation of mechanical and push-on type joints shall comply with AWWA C600 and the manufacturer's instructions. Installation of flanged joints shall comply with manufacturer's instructions.

3.1.4.8 Joints for Steel Pipe

Screw joints shall be made tight with joint tape or joint compound applied with a brush to the male threads only. Installation of mechanical joints, push-on joints, and flanged joints shall comply with the manufacturer's instructions.

3.1.5 Coating and Lining

Field coating of non-galvanized steel pipe shall comply with AWWA C203. The applied materials shall be tested by means of a spark-type electrical device in compliance with AWWA C203. Flaws and holidays in the coating or lining of the pipe and the pipe joints shall be repaired; the repaired areas shall be at least equal in thickness to the minimum required for the pipe.

3.1.6 PE Pipe Encasement

****
NOTE: Loose polyethylene encasement is used in conjunction with ductile or cast iron pipe to protect the pipe from corrosive soils. Review AWWA ANSI/AWWA C105/A21.5 for design requirements and application.
****

[When installed underground, pipe shall be encased with [_____] mil thick polyethylene in accordance with AWWA ANSI/AWWA C105/A21.5.] [Encasement shall be in accordance with AWWA ANSI/AWWA C105/A21.5.]

3.1.7 Installation of Valves

Prior to installation, valves shall be cleaned of all foreign matter and inspected for damage. Valves shall be fully opened and closed to ensure that all parts are properly operating. Valves shall be installed with the stem in the vertical position. [Valves shall be installed in valve vaults as indicated] [_____].

3.1.8 Installation of Valve Boxes

Valve boxes shall be installed over each outside gate valve, unless otherwise indicated. Valve boxes shall be centered over the valve. Fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides or to undisturbed trench face, if less than 4 feet.

3.1.9 Installation of Valve Vaults

Valve vaults shall be installed as indicated.

3.1.10 Drain Lines

Drain lines shall be installed where indicated. The drain line shall consist of a tee in the main line with a 4 inch diameter branch, a 4 inch diameter elbow, and a 4 inch gate valve.

3.1.11 Thrust Restraint

[Thrust Restraint shall be as specified in Section 02510 WATER DISTRIBUTION SYSTEM.] [Plugs, caps, tees and bends deflecting 11-1/4 degrees or more, either vertically or horizontally, shall be provided with thrust restraint.] Valves shall be securely anchored or shall be provided with thrust restraints to prevent movement. Thrust restraints shall be either thrust blocks or, for ductile-iron pipes, restrained joints.

3.1.11.1 Thrust Blocks

Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2000 psi after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

3.1.11.2 Restrained Joints

****
NOTE: When the restrained length is specified by the designer, this paragraph will be modified to delete the design requirement. The Government's designer should use TM 5-813-5 for guidance.
****

For ductile iron pipe, restrained joints shall be designed by the Contractor or the pipe manufacturer in accordance with DIPRA-01.

3.1.12 Grout

Grout for exterior joint protection on concrete pipes shall be a mix of 1 part portland cement, 2 parts sand, and of sufficient liquid consistency to flow into the joint recess beneath the diaper. Grout for interior joint protection shall be a mix of 1 part portland cement and 1 part sand. A polyurethane foam loop, impregnated with portland cement, may be substituted for grout for exterior joints.

3.1.13 Bonded Joints

****
NOTE: Bonded joints will be used to maintain electrical continuity in metallic pipelines where cathodic protection is provided during construction or where it is anticipated that cathodic protection will be provided in the future.
****

Where indicated, a metallic bond shall be provided at each joint, including joints made with flexible couplings or rubber gaskets, of ferrous-metallic piping to effect continuous conductivity. The bond shall be of the thermal-weld type.

3.2 HYDROSTATIC TESTS

****
NOTE: Edit this paragraph to establish responsibility for tests.
****

The pipeline shall be subjected to both a pressure test and a leakage test. [The method proposed for disposal of waste water from hydrostatic tests shall be approved by the Contracting Officer.] [Testing shall be the responsibility of the Contractor.] [Testing shall be performed by an approved independent testing laboratory or by the Contractor subject to approval.] [The test may be witnessed by the Contracting Officer.] The Contracting Officer shall be notified at least 7 days in advance of equipment tests. The final test report shall be delivered to the

Contracting Officer within 30 days of the test.

3.2.1 Pressure Test

After the pipe has been installed, joints completed, thrust blocks have been in place for at least five days, and the trench has been partially backfilled, leaving the joints exposed for examination, the pipe shall be filled with water to expel all air. The pipeline shall be subjected to a test pressure of 100 psi or 150 percent of the working pressure, whichever is greater, for a period of at least one hour. Each valve shall be opened and closed several times during the test. The exposed pipe, joints, fitting, and valves shall be examined for leaks. Visible leaks shall be stopped or the defective pipe, fitting, joints, or valve shall be replaced.

3.2.2 Leakage Test

****

NOTE: When the Contracting Officer determines that less stringent requirements would not have a detrimental impact on the environment, and would not violate Federal, state, or local requirements and would not contaminate any existing or potential water supply or habitable area, less stringent limits may be permitted. The maximum leakage permitted shall not exceed 60 liters per 10 mm nominal diameter per kilometer (25 U.S. gallons per inch nominal diameter per mile) of pipe per day, based on a pressure of 690 kPa (100 psi).

Allowable leakage at other test pressures will be the above limit multiplied by the product of the square root of the test pressure divided by 10. Inferior workmanship or defective material will not be accepted when less stringent requirements are allowed.

****

The leakage test may be conducted subsequent to or concurrently with the pressure test. The amount of water permitted as leakage for the line shall be placed in a sealed container attached to the supply side of the test pump. No other source of supply will be permitted to be applied to the pump or line under test. The water shall be pumped into the line by the test pump as required to maintain the specified test pressure as described for pressure test for a 2 hour period. Exhaustion of the supply or the inability to maintain the required pressure will be considered test failure. PE pipe can experience diametric expansion and pressure elongation during initial testing. The manufacturer shall be consulted prior to testing for special testing considerations. Allowable leakage shall be determined by the following I-P formula:

$L = NDP/K$ Where:

L = Allowable leakage in gallons per hour.

N = Number of joints in length of pipeline tested.

D = Nominal diameter of the pipe in inches.

P = Square root of the test pressure in psig.

K = 7400 for pipe materials.

At the conclusion of the test, the amount of water remaining in the container shall be measured and the results recorded in the test report.

3.2.3 Retesting

If any deficiencies are revealed during any test, such deficiencies shall be corrected and the tests shall be reconducted until the results of the tests are within specified allowances, without additional cost to the Government.

-- End of Section --

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS

CEGS-02556 (October 1998)

Superseding
CEGS-02685 (December 1993)

GUIDE SPECIFICATION FOR CONSTRUCTION

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10/98

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02556

GAS DISTRIBUTION SYSTEM
10/98

****
NOTE: This guide specification covers the requirements for natural or manufactured gas distribution systems designed in accordance with ASME B31.8. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155..

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: This guide specification may be used for specifying liquefied petroleum gas (LPG) if the following modifications are made:

a. Delete all references to fiberglass and polyethylene pipe.

b. Require, where applicable, the LPG distribution system to be in accordance with NFPA 58, Storage and Handling of Liquefied Petroleum Gases, instead of ASME B31.8.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA Manual	(1994; addenda/correction Jan 1996) A.G.A. Plastic Pipe Manual for Gas Service

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B109.2	(1992) Diaphragm Type Gas Displacement Meters (500 Cubic Feet per Hour Capacity and Over)

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5L	(1995; Errata Dec 1997) Line Pipe
API Spec 6D	(1994; Supple 1 June 1996; Supple 2 Dec, 1997) Pipeline Valves (Gate, Plug, Ball, and Check Valves)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1997) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 181/A 181M	(1995b) Carbon Steel Forgings, for General-Purpose Piping
ASTM D 2513	(1996a) Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D 2517	(1994) Reinforced Epoxy Resin Gas Pressure Pipe and Fittings
ASTM D 2683	(1995) Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D 3261	(1996) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3308	(1997) PTFE Resin-Skived Tape
ASTM D 3350	(1996) Polyethylene Plastics Pipe and Fittings Materials

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(1996) Valves - Flanged, Threaded, and Welding End
ASME B16.40	(1985; R 1994) Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems
ASME B31.8	(1995) Gas Transmission and Distribution Piping Systems
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

CODE OF FEDERAL REGULATIONS (CFR)

49 CFR 192	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

COMMERCIAL ITEM DESCRIPTION (CID)

CID A-A-2962	(Basic) Enamel, Alkyd (Metric)

FEDERAL SPECIFICATIONS (FS)

FS TT-E-2784	(Rev A) Enamel (Acrylic-Emulsion, Exterior Gloss and Semigloss) (Metric)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions

NACE INTERNATIONAL (NACE)

NACE RP0185	(1996) Extruded, Polyolefin Resin Coating Systems with Soft Adhesives for Underground or Submerged Pipe
NACE RP0274	(1993) High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)
SSPC SP 1	(1982) Solvent Cleaning
SSPC SP 3	(1995) Power Tool Cleaning
SSPC SP 6	(1994) Commercial Blast Cleaning
SSPC SP 7	(1994) Brush-Off Blast Cleaning

UNDERWRITERS LABORATORIES (UL)

UL Gas&Oil Dir	(1996; Supple) Gas and Oil Equipment Directory

1.2 GENERAL REQUIREMENTS

1.2.1 Welding Steel Piping

Welding and nondestructive testing procedures for pressure piping are specified in Section 05093 WELDING PRESSURE PIPING. Structural members shall be welded in accordance with Section 05090 WELDING, STRUCTURAL.

1.2.2 Jointing Polyethylene and Fiberglass Piping

Piping shall be joined by performance qualified joiners using qualified procedures in accordance with AGA Manual. Manufacturer's prequalified joining procedures shall be used. Joints shall be inspected by an inspector qualified in the joining procedures being used and in accordance with AGA Manual. Joiners and inspectors shall be qualified at the jobsite by a person who has been trained and certified by the manufacturer of the pipe, to train and qualify joiners and inspectors in each joining procedure to be used on the job. Training shall include use of equipment, explanation of the procedure, and successfully making joints which pass tests specified in AGA Manual. The Contracting Officer shall be notified at least 24 hours in advance of the date to qualify joiners and inspectors.

1.2.3 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos shall not be used. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Valves, flanges, and fittings shall be marked in accordance with MSS SP-25.

1.2.4 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.2.5 Handling

Pipe and components shall be handled carefully to ensure a sound, undamaged condition. Particular care shall be taken not to damage pipe coating. No pipe or material of any kind shall be placed inside another pipe or fitting after the coating has been applied, except as specified in paragraph INSTALLATION. Plastic pipe shall be handled in conformance with AGA Manual.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Pipe, Fittings, and Associated Materials; [_____].

Drawings shall contain complete schematic and piping diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of the system and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-07 Schedules

Equipment and Materials; [_____].

A complete list of equipment and materials, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions, including, but not limited to the following:

a. Dielectric Unions and Flange Kits.

b. Meters.

c. Pressure Reducing Valves.

d. Regulators.

e. [Earthquake Actuated Automatic Gas Shutoff System]

f. Emergency Gas Supply Connection.

Spare Parts Data; [_____].

Spare parts lists for each different item of material and equipment specified, after approval of the detail drawings and not later than [_____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

Notification; [_____].

Notification of the Contractor's schedule for making connections to existing gas lines, at least 10 days in advance.

SD-08 Statements

Welding Steel Piping; [_____].

A copy of qualified welding procedures along with a list of names and identification symbols of performance qualified welders and welding operators.

Jointing Polyethylene and Fiberglass Piping; GA.

A copy of qualified jointing procedures, training procedures, qualifications of trainer, and training test results for joiners and inspectors.

Connection and Abandonment Procedures; GA.

A copy of procedures for gas line tie in, hot taps, abandonment/removal or demolition, purging, and plugging as applicable in accordance with ASME B31.8.

SD-13 Certificates

Utility Work; [_____].

Certification from the Operating Agency/Utility Company that work for which the Utility is responsible has been completed.

Training; [_____].

A copy of each inspector's and jointer's training certificate with respective test results.

SD-19 Operation and Maintenance Manuals

Gas Distribution System; [_____].

[Six] [_____] copies, in booklet form and indexed, of site specific natural gas operation and maintenance manual for each gas distribution system including system operation, system maintenance, equipment operation, and equipment maintenance manuals described below. If operation and maintenance manuals are provided in a common volume, they shall be clearly differentiated and separately indexed.

The System Operation Manual shall include but not be limited to the following:

a. Maps showing piping layout and locations of all system valves and gas line markers.

b. Step-by-step procedures required for system startup, operation, and shutdown. System components and equipment shall be indexed to the gas maps.

c. Isolation procedures and valve operations to shut down or isolate each section of the system. Valves and other system components shall be indexed to the gas maps.

d. Descriptions of Site Specific Standard Operation Procedures including permanent and temporary pipe repair procedures, system restart and test procedures for placing repaired lines back in service, and procedures for abandoning gas piping and system components.

e. Descriptions of Emergency Procedures including: isolation procedures including required valve operations with valve locations indexed to gas map, recommended emergency equipment, checklist for major emergencies and procedures for connecting emergency gas supply.

The Equipment Operation Manual shall include, but not be limited to, detail drawings, equipment data, and manufacturer supplied operation manuals for all equipment, valves and system components.

The System Maintenance Manuals shall include, but not be limited to:

a. Maintenance check list for entire gas distribution system.

b. Descriptions of site specific standard maintenance procedures.

c. Maintenance procedures for installed cathodic protection systems.

d. Piping layout, equipment layout, and control diagrams of the systems as installed.

e. Identification of pipe materials and manufacturer by location, pipe repair procedures, and jointing procedures at transitions to other piping materials or piping from different manufacturer.

The Equipment Maintenance Manuals shall include but not be limited to the following:

a. Identification of valves and other equipment by materials, manufacturer, vendor identification and location.

b. Maintenance procedures and recommended maintenance tool kits for all valves and equipment.

c. Recommended repair methods, either field repair, factory repair, or whole-item replacement for each valve component or piece of equipment or component item.

d. Routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide.

PART 2 PRODUCTS

2.1 PIPE, FITTINGS, AND ASSOCIATED MATERIALS

2.1.1   Steel Pipe

****
NOTE: Other material, such as ductile iron in iron pipe sizes, may be used with gases noncorrosive to such material. Delete inapplicable materials or equipment. Verify that pipe wall thickness conforms to ASME B31.8 for larger sizes and high pressures.
****

Steel pipe shall conform to ASTM A 53, Grade A or B, Type E or S, Schedule 40; or API Spec 5L seamless or electric resistance welded, Schedule 40, black steel pipe as specified in ASME B31.8. Furnace buttwelded pipe may be used in sizes 1-1/2 inches and smaller.

2.1.2   Small Fittings

Fittings 1-1/2 inches and smaller shall conform to ASME B16.11.

2.1.3   Fittings, 2 Inches and Larger

Pipe flanges and flanged fittings including bolts, nuts, and bolt patterns shall be in accordance with ASME B16.5, Class [_____]. Buttweld fittings shall be in accordance with ASME B16.9. Weld neck flanges shall be used.

2.1.4   Steel Forged Branch Connections

Connections shall conform to ASTM A 181/A 181M, Class 60, carbon steel.

2.1.5   Flange Gaskets

Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch minimum thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with nitrile butadiene rubber (NBR), or glass fibers bonded with polytetrafluoroethylene, suitable for maximum 600 degrees F service and meeting applicable requirements of ASME B31.8.

2.1.6   Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

2.1.7   Polyethylene Pipe, Tubing, Fittings and Joints

****
NOTE: Before selecting polyethylene or fiberglass pipe material, the gas supplier should be contacted for a gas analysis to determine the types of chemicals which will be in the gas he will supply. Suitable polyethylene or fiberglass pipe material will be selected based on the gas analysis.

Polyethylene shall not be used for gas lines with design pressures above 690 kPa (100 psig) or with operating temperatures below 7 degrees C (20 degrees F) or above 60 degrees C (140 degrees F).

For thermoplastic (polyethylene) pipe in sizes from 15 mm through 150 mm (1/2 inch through 6 inches), select minimum wall thickness based on ASME B31.8, table 842.32(c); and select the standard dimension ratio (SDR) based on the long-term hydrostatic strength of S = 8.6 MPa (1,250 psi) for PE 2406 or S = 11 MPa (1,600 psi) for PE 3408 at 23 degrees C (73 degrees F) for the following pressures:

SDR	Design Pressure at 23 degrees C (73 Degrees F)			
	S = 8.62 MPa	(1,250 psi)	S = 11 MPa	(1,600 psi)
11	550 kPa	(80 psig)	690 MPa	(100 psig)
13.5	415 kPa	(60 psig)	550 kPa	(80 psig)
17	345 kPa	(50 psig)	415 kPa	(60 psig)
21	275 kPa	(40 psig)	345 kPa	(50 psig)
26	207 kPa	(30 psig)	275 kPa	(40 psig)

Where the buried pipe system is expected to exceed 23 degrees C (73 degrees F) at the design pressures stated above, alternate materials must be used.

****

Polyethylene pipe, tubing, fittings and joints shall conform to ASTM D 3350 and ASTM D 2513, pipe designations PE 2406 and PE 3408, rated SDR [_____] or less, as specified in ASME B31.8. Pipe sections shall be marked as required by ASTM D 2513. Butt fittings shall conform to ASTM D 3261 and socket fittings shall conform to ASTM D 2683. Fittings shall match the service rating of the pipe. Minimum wall thickness shall be [_____].

2.1.8 Fiberglass Pipe, Fittings and Adhesive

****

NOTE: Before selecting polyethylene or fiberglass pipe material, the gas supplier should be contacted for a gas analysis to determine the types of chemicals which will be in the gas he will supply. Suitable polyethylene or fiberglass pipe materials must be selected based on the gas analysis.

Reinforced thermosetting plastic (fiberglass reinforced plastic) shall not be used for gas lines with design pressures above 690 kPa (100 psig) or with operating temperatures below 29 degrees C (minus 20 degrees F) or above 66 degrees C (150 degrees F).

For reinforced thermosetting plastic (fiberglass reinforced plastic) pipe sizes from 50 mm through

150 mm (2 inches through 6 inches), select minimum wall thickness based on ASME B31.8, table 842.33(c).
****

Fiberglass pipe, fittings and adhesive shall conform to ASTM D 2517. Pipe sections shall be marked as required by ASTM D 2517. Minimum wall thickness shall be [_____].

2.1.9 Sealants for Steel Pipe Threaded Joints

2.1.9.1 Sealing Compound

Joint sealing compound shall be as listed in UL Gas&Oil Dir, Class 20 or less.

2.1.9.2 Tape

Polytetrafluoroethylene tape shall conform to ASTM D 3308.

2.1.10 Identification

Pipe flow markings and metal tags for each valve, meter, and regulator shall be provided as required by the Contracting Officer.

2.1.11 Insulating Joint Materials

Insulating joint materials shall be provided between flanged or threaded metallic pipe systems where shown to isolate galvanic or electrolytic action.

2.1.11.1 Threaded Joints

Joints for threaded pipe shall be steel body nut type dielectric type unions with insulating gaskets.

2.1.11.2 Flanged Joints

Joints for flanged pipe shall consist of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts and insulating washers for flange nuts.

2.1.12 Gas Transition Fittings

Gas transition fittings shall be manufactured steel fittings approved for jointing steel and polyethylene or fiberglass pipe. Approved transition fittings are those that conform to AGA Manual requirements for transition fittings.

2.2 VALVES

****
NOTE: Valves and pressure regulators are necessary at all points where design requires pressure reduction or regulation. Require a shut-off valve upstream of the regulator. A central regulating station is generally provided by the gas company and is usually located near the entrance to the installation. When valves, gas pressure regulators,

and related devices are required in the contract, ensure that all necessary equipment will comply with the requirements of the gas company, and revise these paragraphs as required. Provide a detail of each regulating station and the following data for each pressure regulator: materials of construction, flow rate, type and specific gravity of the gas, inlet and outlet pressures, accuracy of control, and size and type of connections.
****

Valves shall be suitable for shutoff or isolation service and shall conform to the following:

2.2.1 Steel Valves

Steel valves 1-1/2 inches and smaller installed underground shall conform to ASME B16.34, carbon steel, socket weld ends, with square wrench operator adaptor. Steel valves 1-1/2 inches and smaller installed aboveground shall conform to ASME B16.34, carbon steel, socket weld or threaded ends with handwheel or wrench operator. Steel valves 2 inches and larger installed underground shall conform to API Spec 6D, carbon steel, buttweld ends, Class [_____] with square wrench operator adaptor. Steel valves 2 inches and larger installed aboveground shall conform to API Spec 6D, carbon steel, buttweld or flanged ends, Class [_____] with handwheel or wrench operator.

2.2.2 Steel Valve Operators

Valves 8 inches and larger shall be provided with worm or spur gear operators, totally enclosed, grease packed, and sealed. The operators shall have Open and Closed stops and position indicators. Locking feature shall be provided where indicated. Wherever the lubricant connections are not conveniently accessible, suitable extensions for the application of lubricant shall be provided. Valves shall be provided with lubricant compatible with gas service.

2.2.3 Polyethylene Valves

Polyethylene valves shall conform to ASME B16.40. Polyethylene valves, in sizes 1/2 inch to 6 inches, may be used with polyethylene distribution and service lines, in lieu of steel valves, for underground installation only.

2.3 PRESSURE REGULATORS

****
NOTE: Coordinate this paragraph with the specified requirements in paragraph VALVES.
****

Regulators shall have ferrous bodies, shall provide backflow and vacuum protection, and shall be designed to meet the pressure, load and other service conditions.

2.3.1 Gas Main Regulators

Pressure regulators for main distribution lines, supplied from a source of gas which is at a higher pressure than the maximum allowable operating pressure for the system, and shall be equipped with pressure regulating devices of adequate capacity. In addition to the pressure regulating devices, a suitable method shall be provided to prevent overpressuring of the system in accordance with ASME B31.8. Suitable protective devices are as follows:

a. Spring-loaded relief valve meeting the provisions of ASME BPV VIII Div 1.

b. Pilot-loaded back pressure regulator used as relief valve, so designed that failure of the pilot system will cause the regulator to open.

c. Weight-loaded relief valves.

d. Monitoring regulator installed in series with the primary pressure regulator.

e. Series regulator installed upstream from the primary regulator, set to limit the pressure on the inlet of the primary regulator continuously to the maximum allowable operating pressure of the system, or less.

f. Automatic shutoff device installed in series with the primary regulator, set to shut off when the pressure on the distribution system reaches the maximum allowable operating pressure of the system, or less. This device shall remain closed until manually reset.

g. Spring-loaded, diaphragm type relief valves.

2.3.2 Service Line Regulators

****

NOTE: If service regulator does not have all the characteristics listed, or if gas contains materials which would interfere with operation of the regulator, protective devices will be installed to prevent overpressuring of the user's system should the regulator fail. The following devices should be considered to be installed as an integral part of the regulator or as separate devices operating in conjunction with the regulator.

a. Monitoring regulator

b. Relief valve

c. Automatic shutoff device

****

Pressure regulators for individual service lines shall have ferrous bodies. Regulator shall be capable of reducing distribution line pressure to pressures required for users. Regulators shall be provided where gas will be distributed at pressures in excess of 10 inches of water column. Pressure relief shall be set at a lower pressure than would cause unsafe operation of any connected user. Regulators for liquified petroleum gas shall be adjusted to 10 to 12 inches of water column. Pressure relief for liquified petroleum gas shall be set at 16 inches of water column. Regulator shall have single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas pressure at the regulator inlet. Regulator valve vent shall be of resilient materials designed to withstand flow conditions when pressed against the valve port. Regulator shall be capable of regulating downstream pressure within limits of accuracy and shall be capable of limiting the buildup of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Regulator shall have a self contained service regulator. Regulator pipe connections shall not exceed 2 inchsize.

2.4 METERS

****

NOTE: Provide gas meters for each service line to every building. Where meters have a maximum anticipated demand of less than 28 cubic meters/hour (1000 SCFH), require the meter to meet a design working pressure of 690 kPa (100 psi).

Delete mounting and special features that are not required. Retain strainer upstream of meter only if installed upstream of pressure regulator. Delete pulse switch and pulse requirements except for Air Force projects or when required by other users. Air Force Engineering Technical Letter Number 87-5 "Utility Meters in New and Renovated Facilities" provides guidance for when to exclude meters from Air Force new and major renovation projects. Review the requirements for gas meters in the AEI (page C.11. par. 2f) and 10 CFR 435.

****

Meters shall conform to ANSI B109.2. Meters shall be [pipe] [pedestal] mounted [and be provided with a strainer immediately upstream]. [Meters shall be provided with [over-pressure protection as specified in ASME B31.8] [tamper-proof protection] [frost protection] [fungus-proof protection].] Meters shall be suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates indicated. Meters shall have a pulse switch initiator capable of operating up to speeds of 500 pulses per minute with no false pulses and shall require no field adjustments. Initiators shall provide the maximum number of pulses up to 500 per minute that is obtainable from the manufacturer. It shall provide not less than one pulse per 100 cubic feet of gas.

2.5 EARTHQUAKE ACTUATED AUTOMATIC GAS SHUTOFF SYSTEM

****

NOTE: Include earthquake actuated automatic gas shutoff system if the facility is either essential or hazardous and is located within Seismic Zone 3 or 4. The designer will determine the classification of the facility per TM 5-809-10 and provide a detail on the drawings showing this system.

ASCE has developed a "Public-Approved Version" of ASCE 25-97 EARTHQUAKE ACTUATED AUTOMATIC GAS SHUTOFF DEVICES, dated March 27, 1998, which includes a test procedure to verify that the valve will activate

during strong ground shaking but will not activate for minor ground shaking or accidental bumping by a pedestrian or vehicle.

The State of California, Division of the State Architect/Real Estate Services Division maintains a list of devices that have been tested and conform to the ASCE Standard; inquiries can be directed to telephone no. 916-445-2600.

Show the earthquake actuated automatic gas shutoff on the drawings when required in the project. The designer must fill the bracketed blank and ensure that a copy of ASCE 25-97 is included with the Contract documents.
****

Earthquake Actuated Automatic Gas Shutoff devices shall conform to [_____] [and] [requirements furnished by the Contracting Officer], and shall be listed by the State of California, Division of the State Architect as being tested and in conformance with specified requirements. The system shall safely interrupt the flow of gas to the building due to strong ground shaking of an earthquake.

2.6 EMERGENCY GAS SUPPLY CONNECTION

****
NOTE: Include emergency gas supply connections when the customer determines the ability to provide gas to the building is necessary during an outage of the gas distribution system. Show the emergency gas piping connection on the drawings when required in the project.
****

The emergency gas supply connection shall consist of piping (same size as service line) and accessories that will enable a portable, commercial-sized gas cylinder system to be connected to the gas piping system. This connection shall be capped to prevent gas leakage with a lockable manual valve located to be capable of shutting off flow. The entire assembly should be contained in a weatherproof, lockable box. The box shall contain permanently installed written instructions stating the type and pressure of the gas allowed to be connected to the line. The instructions shall also indicate and provide specific instruction for testing of the integrity of the building's gas system with an inert gas before the fuel gas connection is made. A subplate shall be provided in the box that is required to be unbolted to gain access to the connection. The subplate shall contain a warning regarding the potential consequences of using gas other than that specified or of failing to test system integrity before hooking up emergency fuel supply.

2.7 PROTECTIVE COVERING MATERIALS

Continuously extruded polyethylene and adhesive coating system materials shall conform to NACE RP0185, Type A.

2.8 TELEMETERING OR RECORDING GAUGES

****
NOTE: On distribution systems supplied by a single district pressure regulating station, the designer will determine the necessity of installing telemetering or recording gauges in the supply line, taking into consideration the number of buildings supplied, the operating pressures, the capacity of installation, and other operating conditions.
****

Each distribution system supplied by more than one district pressure regulating station shall be equipped with telemetering or recording pressure gauges to indicate the gas pressure in the district line.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILLING

Earthwork shall be as specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.2 GAS MAINS

Pipe for gas mains shall be [steel] [polyethylene] [or] [fiberglass]. [Steel pipe and fittings shall be coated with protective covering as specified.] [Polyethylene or fiberglass mains shall not be installed aboveground.]

3.3 SERVICE LINES AND EMERGENCY GAS SUPPLY CONNECTION

****
NOTE: Service line isolation valve will be located as close to the supply main as possible but at a safe distance from traffic lanes.
****

Service lines shall be constructed of materials specified for gas mains and shall extend from a gas main to and including the point of delivery within 5 feet of the building. The point of delivery is the [meter set assembly] [service regulator] [shutoff valve]. The service lines shall be connected to the gas mains [as indicated] [through service tees, with end of run plugged]. Where indicated, service line shall be provided with an isolation valve of the same size as the service line. The service lines shall be as short and as straight as practicable between the point of delivery and the gas main and shall not be bent or curved laterally unless necessary to avoid obstructions or otherwise permitted. Service lines shall be laid with as few joints as practicable using standard lengths of pipe. Shorter lengths shall be used only for closures. Polyethylene or fiberglass service lines shall not be installed aboveground except as permitted in ASME B31.8.

3.3.1 Emergency Gas Supply Connection

****
NOTE: If it is expected that a portable gas tank providing pressure regulated gas would be provided during an emergency, locate the emergency gas

connection downstream of the building's pressure regulator.
****

An aboveground locked, valved and capped emergency gas supply connection shall be provided [downstream] [upstream] of the pressure regulator. The connection shall be located outside of the building within 12 inches of the exterior wall and installed in a weatherproof box which is mounted on the exterior wall and clearly marked with an appropriate metal sign mounted on wall above.

3.4 WORKMANSHIP AND DEFECTS

Pipe, tubing, and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and blown free of chips and scale. Defective pipe, tubing, or fittings shall be replaced and shall not be repaired.

3.5 PROTECTIVE COVERING

3.5.1 Protective Covering for Underground Steel Pipe

Except as otherwise specified, protective coverings shall be applied mechanically in a factory or field plant especially equipped for the purpose. Valves and fittings that cannot be coated and wrapped mechanically shall have the protective covering applied by hand, preferably at the plant that applies the covering to the pipe. Joints shall be coated and wrapped by hand. Hand coating and wrapping shall be done in a manner and with materials that will produce a covering equal in thickness to that of the covering applied mechanically.

3.5.1.1 Thermoplastic Resin Coating System

The coating system shall conform to NACE RP0185, Type A. The exterior of the pipe shall be cleaned to a commercial grade blast cleaning finish in accordance with SSPC SP 6. Adhesive compound shall be applied to the pipe. Immediately after the adhesive is applied, a seamless tube of polyethylene shall be extruded over the adhesive to produce a bonded seamless coating. The nominal thickness of the pipe coating system shall be 10 mils (plus or minus 10 percent) of adhesive and 40 mils (plus or minus 10 percent) of polyethylene for pipes up to 16 inches in diameter. For pipes 18 inches and larger in diameter, the pipe coating system thickness shall be 10 mils (plus or minus 10 percent) adhesive and 60 mils (plus or minus 10 percent) polyethylene. Joint coating and field repair material shall be applied as recommended by the coating manufacturer and shall be one of the following:

a. Heat shrinkable polyethylene sleeves.

b. Polyvinyl chloride pressure-sensitive adhesive tape.

c. High density polyethylene/bituminous rubber compound tape.

The coating system shall be inspected for holes, voids, cracks, and other damage during installation.

3.5.1.2 Inspection of Pipe Coatings

Any damage to the protective covering during transit and handling shall be repaired before installation. After field coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current set at a value in accordance with NACE RP0274 using a full-ring, spring-type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. All holidays in the protective covering shall be repaired immediately upon detection. The Contracting Officer reserves the right to inspect and determine the suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection shall be furnished by the Contractor.

3.5.2 Protective Covering for Aboveground Piping Systems

Finish painting shall conform to the applicable paragraphs of Section 09900 PAINTING, GENERAL and as follows:

3.5.2.1 Ferrous Surfaces

Shop primed surfaces shall be touched up with ferrous metal primer same type paint as the shop primer. Surfaces that have not been shop primed shall be solvent-cleaned in accordance with SSPC SP 1. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be mechanically cleaned by power wire brushing in accordance with SSPC SP 3 or brush-off blast cleaned in accordance with SSPC SP 7 and primed with ferrous metal primer in accordance with SSPC Paint 25. Primed surfaces shall be finished with two coats of exterior alkyd paint conforming to CID A-A-2962 Type I, Class [A] [B], Grade B.

3.5.2.2 Nonferrous Surfaces

****

NOTE: Retain only the first sentence for normal conditions; delete the first sentence for corrosive conditions.

****

[Nonferrous surfaces shall not be painted.] [Nonferrous surfaces shall be painted due to corrosive conditions. The surfaces shall be solvent-cleaned in accordance with SSPC SP 1. A first coat of FS TT-E-2784, Type III, Flat, and 2 coats of FS TT-E-2784, Enamel [Type I, Gloss] [or] [Type II, Semigloss] shall be applied.]

3.5.3 Protective Covering for Piping in Valve Boxes and Manholes

Piping in valve boxes or manholes shall receive protective coating as specified for underground steel pipe.

3.6 INSTALLATION

****

NOTE: When existing gas piping is abandoned, show disconnect details on the drawings. Refer to ASME B31.8 for guidance on preparing the disconnect details. ASME B31.8 requires physical disconnection from gas sources. Shutoff valves are not an acceptable means of disconnect.

****

Gas distribution system and equipment shall be installed in conformance with the manufacturer's recommendations and applicable sections of ASME B31.8, AGA Manual and 49 CFR 192. Abandoning existing gas piping shall be done in accordance with ASME B31.8. Pipe shall be cut without damaging the pipe. Unless otherwise authorized, cutting shall be done by an approved type of mechanical cutter. Wheel cutters shall be used where practicable. On steel pipe 6 inches and larger, an approved gas-cutting-and-beveling machine may be used. Cutting of plastic pipe shall be in accordance with AGA Manual. Valve installation in plastic pipe shall be designed to protect the plastic pipe against excessive torsional or shearing loads when the valve is operated and from other stresses which may be exerted through the valve or valve box.

3.6.1 Installing Pipe Underground

****

NOTE: Indicate profile of gas lines on the drawing. If it is impractical to comply with the minimum cover specified for pipe, and necessary to prevent damage from external loads, the pipe will be installed in a casing. The locations of all casings and details of the installation will be indicated.

****

Gas mains and service lines shall be graded as indicated. Joints in steel pipe shall be welded except as otherwise permitted for installation of valves. Mains shall have 24 inch minimum cover; service lines shall have 18 inch minimum cover; and both mains and service lines shall be placed on firmly compacted select material for the full length. Where indicated, the main shall be encased, bridged, or designed to withstand any anticipated external loads as specified in ASME B31.8. The encasement material shall be standard weight black steel pipe with a protective coating as specified. The pipe shall be separated from the casing by insulating spacers and sealed at the ends with casing bushings. Trench shall be excavated below pipe grade, bedded with bank sand, and compacted to provide full-length bearing. Laying the pipe on blocks to produce uniform grade will not be permitted. The pipe shall be clean inside before it is lowered into the trench and shall be kept free of water, soil, and all other foreign matter that might damage or obstruct the operation of the valves, regulators, meters, or other equipment. When work is not in progress, open ends of pipe or fittings shall be securely closed by expandable plugs or other suitable means. Minor changes in line or gradient of pipe that can be accomplished through the natural flexibility of the pipe material without producing permanent deformation and without overstressing joints may be made when approved. Changes in line or gradient that exceed the limitations specified shall be made with fittings. When cathodic protection is furnished, electrically insulated joints or flanges shall be provided. When polyethylene or fiberglass piping is installed underground, foil backed magnetic tape shall be placed above the pipe to permit locating with a magnetic detector. After laying of pipe and testing, trench shall be backfilled in accordance with Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITY SYSTEMS.

3.6.2 Installing Pipe Aboveground

Aboveground piping shall be protected against dirt and other foreign matter as specified for underground piping. Joints in steel pipe shall be welded; however, joints in pipe 1-1/2 inches in diameter and smaller may be threaded; joints may also be threaded to accommodate the installation of valves. Flanges shall be of the weld neck type to match wall thickness of pipe.

3.7 PIPE JOINTS

Pipe joints shall be designed and installed to effectively sustain the longitudinal pullout forces caused by the contraction of piping or superimposed loads.

3.7.1 Threaded Steel Joints

Threaded joints in steel pipe shall have tapered threads evenly cut and shall be made with UL approved graphite joint sealing compound for gas service or polytetrafluoroethylene tape applied to the male threads only. Caulking of threaded joints to stop or prevent leaks will not be permitted.

3.7.2 Welded Steel Joints

Gas pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.8. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected adversely. Electrodes that have been wetted or have lost any of their coating shall not be used.

3.7.3 Polyethylene and Fiberglass Pipe Jointing Procedures

Jointing procedures shall conform to AGA Manual. Indiscriminate heat fusion joining of plastic pipe or fittings made from different polyethylene resins by classification or by manufacturer shall be avoided if other alternative joining procedures are available. If heat fusion joining of dissimilar polyethylenes is required, special procedures are required. The method of heat fusion joining dissimilar polyethylene resins shall be tested in accordance with paragraph TESTS, subparagraph Destructive Tests of Plastic Pipe Joints.

3.7.4 Connections Between Metallic and Plastic Piping

Connections shall be made only outside, underground, and with approved transition fittings.

3.8 VALVE BOXES

Valve boxes of cast iron not less than 3/16 inch thick shall be installed at each underground valve except where concrete or other type of housing is indicated. Valve boxes shall be provided with locking covers that require a special wrench for removal. Wrench shall be furnished for each box. The word "gas" shall be cast in the box cover. When the valve is located in a roadway, the valve box shall be protected by a suitable concrete slab at least 3 square feet. When in a sidewalk, the top of the box shall be in a concrete slab 2 feet square and set flush with the sidewalk. Boxes shall be adjustable extension type with screw or slide-type adjustments. Valve boxes shall be separately supported, not resting on the pipe, so that no traffic loads can be transmitted to the pipe. Valves shall only be located in valve boxes or inside of buildings.

3.9 DRIPS

****

NOTE: If gas mains are for the distribution of high-pressure natural gas (above 400 kPa (60 psig)) only, delete the entire paragraph: DRIPS. Require drips for lines transmitting natural gas at the low point immediately following reduction from high pressure (above 400 kPa (60 psig)) to medium pressure (400 kPa (60 psig) or less), and at occasional low points throughout the system, to provide for blowing out the lines. Require drips at all low points in lines transmitting manufactured gas or a mixture of manufactured and natural gas. Indicate locations of drips. Locate drip points to provide for proper drainage of pipe system. Detail drips and discharge terminal (outlet) piping. If the need to contain and dispose of liquids through the valve for environmental concerns is required, delete the first bracketed sentence.

****

Drips shall be installed at locations where indicated. Drips shall conform to the details shown or may be commercial units of approved type and capacity. A blow off pipe 1-1/4 inches or larger shall be connected to each drip at its lowest point and shall extend to or near the ground surface at a convenient location away from traffic. Discharge for each drip terminal (outlet) shall be provided with a reducing fitting, a plug valve, and a 1/2 inch nipple turned down. The discharge terminal (outlet) shall be inside a length of 12 inches or larger vitrified clay pipe, concrete sewer pipe or concrete terminal box [set vertically on a bed of coarse gravel 1 foot thick and 3 feet square,] [with concrete bottom to contain liquids and a connection to remove liquids for disposal,] and closed at the ground surface with a suitable replacement cover.

3.10 PRESSURE REGULATOR INSTALLATION

3.10.1 Main Distribution Line Regulators

****

NOTE: Remove reference to bypasses around pressure regulators for main distribution lines unless continuity of service is imperative and the bypass is regulated to prevent possible overpressure of downstream lines.

****

Pressure regulators shall be installed where shown. A valve shall be installed on each side of the regulator for isolating the regulator for maintenance. A bypass line with bypass valves or 3 way valves and an overpressurization pressure regulating device shall be provided. Regulators and valves shall be installed in rectangular reinforced concrete boxes. Boxes shall be large enough so that all required equipment can be properly installed, operated, and maintained. Sidewalls shall extend above ground line. The boxes shall be provided with [steel door] [cast iron manhole] covers with locking provisions and 4 inch diameter vents. One key or other unlocking device shall be furnished with each cover. Discharge stacks, vents, or outlet ports of all pressure relief devices shall be located where gas can be discharged into the atmosphere without undue hazard. Stacks and vents shall be provided with fittings to preclude entry of water.

3.10.2 Service Line Regulators

****
NOTE: Delete inapplicable requirements.
****

A shutoff valve, meter set assembly, and service regulator shall be installed on the service line outside the building, 18 inches above the ground on the riser. An insulating joint shall be installed on the inlet side of the meter set assembly and service regulator and shall be constructed to prevent flow of electrical current. A 3/8 inch tapped fitting equipped with a plug shall be provided on both sides of the service regulator for installation of pressure gauges for adjusting the regulator. All service regulator vents and relief vents shall terminate in the outside air in rain and insect resistant fittings. The open end of the vent shall be located where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding.

3.11 METER INSTALLATION

Meters shall be installed in accordance with ASME B31.8. Permanent gas meters shall be installed with provisions for isolation and removal for calibration and maintenance, and shall be suitable for operation in conjunction with an energy monitoring and control system.

3.12 CONNECTIONS TO EXISTING LINES

****
NOTE: If connections to existing mains are required, retain this subparagraph, and select the appropriate Paragraph. Drawings will show existing gas lines when interface with the existing gas system is required.
****

Connections between new work and existing gas lines, where required, shall be made in accordance with ASME B31.8, using proper fittings to suit the actual conditions. When connections are made by tapping into a gas main, the connecting fittings shall be the same size as the pipe being connected.

3.12.1 Connections to Publicly or Privately Operated Gas Utility Lines

****
NOTE: Delete inapplicable requirements.
****

Contractor shall provide materials for the connections to the existing gas lines. Final connections and the turning on of gas shall be made by the utility. Existing lines that are to be a abandoned or taken out of service shall be disconnected, purged and capped, plugged or otherwise effectively sealed by the Utility. The Contractor shall notify the Contracting Officer, in writing, 10 days before final connections and turning on of gas lines. The Contractor shall make necessary arrangements with the Utility for tie in and activation of new gas lines. Only the Operating Agency/Utility Company may reactivate the system after tie in. The Contractor shall furnish a certification by the Operating Agency/Utility Company that all Utility work has been satisfactorily completed.

3.12.2 Connection to Government Owned/Operated Gas Lines

****

NOTE: Provide the name and location of the utility or operating agency of the existing gas lines. Show on the drawings, the location of valves to be operated for existing system deactivation. When lines are to be abandoned, consideration shall be given to any effects the abandonment may have on an active cathodic protection system and appropriate action taken. If the segment is long and there are few line valves, consideration should be given to plugging the abandoned segment at intervals.

****

The Contractor shall provide connections to the existing gas lines in accordance with approved procedures. Deactivation of any portion of the existing system shall only be done at the valve location shown on the drawings. Reactivation of any existing gas lines will only be done by the Government. The Contractor's Connection and Abandonment Plan shall be submitted and approved prior to making any connections to existing gas lines. This plan shall include the Operating Agency's required procedures which may be obtained from [_____]. The Contractor shall notify the Contracting Officer, in writing, 10 days before connections to existing lines are to be made.

a. If facilities are abandoned in place, they shall be physically disconnected from the piping system. The open ends of all abandoned facilities shall be purged, capped, plugged or otherwise effectively sealed. Abandonment shall not be completed until it has been determined that the volume of gas or liquid hydrocarbons contained within the abandoned section poses no potential hazard. Air or inert gas may be used for purging, or the facility may be filled with water or other inert material. If air is used for purging, the Contractor shall ensure that a combustible mixture is not present after purging.

b. When a main is abandoned, together with the service lines connected to it, only the customer's end of such service lines is required to be sealed as stipulated above.

c. Service lines abandoned from the active mains shall be disconnected as close to the main as practicable.

d. All valves left in the abandoned segment shall be closed.

e. All abovegrade valves, risers, and vault and valve box covers shall be removed. Vault and valve box voids shall be filled with suitable compacted backfill material.

3.13 CATHODIC PROTECTION

****
NOTE: Cathodic protection is mandatory for underground metallic gas distribution lines. The type and design of cathodic protection will be in accordance with TM 5-811-7. Stations will be provided for testing the cathodic protection system.
****

Cathodic protection shall be provided for all metallic gas piping installed underground and shall be installed as specified in [Section 13110CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [Section 13112 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)].

3.14 TESTS

3.14.1 Destructive Tests of Plastic Pipe Joints

****
NOTE: Destructive tests of plastic pipe joints are provided as a designer option. Destructive tests are considered useful in assuring that good joints will be made. Delete the paragraph if this option is not exercised.
****

Each day, prior to making polyethylene heat fusion joints or fiberglass adhesive joints, a joint of each size and type to be installed that day shall be made by each person performing joining of plastic pipe that day and destructively tested. At least 3 longitudinal straps shall be cut from each joint. Each strap shall be visually examined, shall not contain voids or discontinuities on the cut surfaces of the joint area, and shall be deformed by bending, torque, or impact, and if failure occurs, it must not initiate in the joint area. If a joint fails the visual or deformation test, the qualified joiner who made that joint shall not make further field joints in plastic pipe on this job until that person has been retrained and requalified. The results of the destructive tests shall be recorded to include the date and time of the tests, size and type of the joints, ambient conditions, fusion iron temperature and names of inspectors and joiners.

3.14.2 Pressure and Leak Tests

****
NOTE: Specify correct test pressure (including Class Location) to be used for tests of gas line systems in accordance with ASME B31.8. Test pressures should recognize the weakest component of each system tested for the design pressure, the maximum allowable operating pressure, and the gas supplier's maximum operating pressure.

The test pressure shall be 150 percent of the maximum operating pressure or 350 kPa (50 psig), whichever is greater. However, the maximum test pressure shall not be more than three times the design pressure of the pipe.

****

The system of gas mains and service lines shall be tested after construction and before being placed in service using air as the test medium. The normal operating pressure for the system is [_____]. The test pressure is [_____]. Prior to testing the system, the interior shall be blown out, cleaned and cleared of all foreign materials. All meters, regulators, and controls shall be removed before blowing out and cleaning and reinstalled after clearing of all foreign materials. Testing of gas mains and service lines shall be done with due regard for the safety of employees and the public during the test. Persons not working on the test operations shall be kept out of the testing area while testing is proceeding. The test shall be made on the system as a whole or on sections that can be isolated. Joints in sections shall be tested prior to backfilling when trenches must be backfilled before the completion of other pipeline sections. The test shall continue for at least 24 hours from the time of the initial readings to the final readings of pressure and temperature. The initial test readings of the instrument shall not be made for at least 1 hour after the pipe has been subjected to the full test pressure, and neither the initial nor final readings shall be made at times of rapid changes in atmospheric conditions. The temperatures shall be representative of the actual trench conditions. There shall be no indication of reduction of pressure during the test after corrections have been made for changes in atmospheric conditions in conformity with the relationship T(1)P(2)=T(2)P(1), in which T and P denote absolute temperature and pressure, respectively, and the numbers denote initial and final readings. During the test, the entire system shall be completely isolated from all compressors and other sources of air pressure. Each joint shall be tested by means of soap and water or an equivalent nonflammable solution prior to backfilling or concealing any work. The testing instruments shall be approved by the Contracting Officer. All labor, materials and equipment for conducting the tests shall be furnished by the Contractor and shall be subject to inspection at all times during the tests. The Contractor shall maintain safety precautions for air pressure testing at all times during the tests.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02630 (September 1998)**
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Superseding
CEGS-02720 (June 1991)

GUIDE SPECIFICATION FOR CONSTRUCTION

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02630

STORM-DRAINAGE SYSTEM
09/98

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NOTE: This guide specification covers the requirements for storm drainage piping systems using concrete, clay, steel, ductile iron, aluminum, polyvinyl chloride (PVC), and polyethylene (PE) pipe. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 346/346R	(1990) Standard Specification for Cast-in-Place Nonreinforced Concrete Pipe and Recommendations

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-16	(1996) Standard Specifications for Highway Bridges
AASHTO M 167	(1994) Corrugated Steel Structural Plate, Zinc Coated, for Field Bolted Pipe
AASHTO M 190	(1988) Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M 198	(1994) Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
AASHTO M 219	(1992) Aluminum Alloy Structural Plate for Field Bolted Conduits
AASHTO M 243	(1994) Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M 294	(1994) Corrugated Polyethylene Pipe, 305- to 915- mm (12-to 36 in.) Diameter
AASHTO MP6	(1995) Corrugated Polyethylene Pipe 1050 and 1200 mm Diameter

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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48	(1994a) Gray Iron Castings
ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 716	(1995) Ductile Iron Culvert Pipe
ASTM A 742/A 742M	(1995) Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
ASTM A 760/A 760M	(1997) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A 762/A 762M	(1997) Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A 798/A 798M	(1997) Installing Factory-Made Corrugated

	Steel Pipe for Sewers and Other Applications
ASTM A 807	(1996) Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications
ASTM A 849	(1996) Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM A 929/A 929M	(1996) Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
ASTM B 26/B 26M	(1997) Aluminum-Alloy Sand Castings
ASTM B 745/B 745M	(1995) Corrugated Aluminum Pipe for Sewers and Drains
ASTM C 12	(1995) Installing Vitrified Clay Pipe Lines
ASTM C 14	(1995) Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 14M	(1995) Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C 32	(1993) Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 55	(1997) Concrete Building Brick
ASTM C 62	(1997) Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 76	(1997) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 76M	(1997) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 139	(1997) Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 270	(1997a) Mortar for Unit Masonry
ASTM C 425	(1997) Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443	(1994) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	(1997) Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(1997) Precast Reinforced Concrete Manhole

	Sections (Metric)
ASTM C 506	(1995a) Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C 506M	(1995a) Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 507	(1995a) Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
ASTM C 507M	(1995a) Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 655	(1995a) Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C 700	(1997) Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 789	(1995a) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
ASTM C 828	(1990; R 1996) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C 850	(1995a) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 ft of Cover Subjected to Highway Loadings
ASTM C 877	(1994) External Sealing Bands for Noncircular Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 924	(1989; R 1997) Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
ASTM C 1103	(1994) Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C 1103M	(1994) Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric)
ASTM D 1056	(1991) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1171	(1994) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))

ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 1784	(1997) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2321	(1989; R 1995) Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3034	(1994) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3350	(1996) Polyethylene Plastics Pipe and Fittings Materials
ASTM F 477	(1995) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	(1995) Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F 714	(1994) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(1995a) Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(1995) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F 949	(1994) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F 1417	(1992) Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

1.2 MEASUREMENT AND PAYMENT

****
NOTE: Delete this paragraph when the work specified is included in a lump-sum contract price.

Separate bid may be required for each item for the construction of the various sizes of pipe culverts and storm drains and individual miscellaneous drainage structures, including all excavation, materials, backfilling, etc., for the completed work. If separate bid items are used for the excavation, this fact should be clearly stated in the specifications and bid form, indicating that payment is to be made separately for earth excavation, rock excavation, borrow excavation, or other items that otherwise might be construed as the basis for a claim by the Contractor. Unit prices for rock excavation should be independent of, and not in addition to, the unit bid price for common excavation, unless so specified and so stated in the bid form.
****

1.2.1 Pipe Culverts and Storm Drains

The length of pipe installed will be measured along the centerlines of the pipe from end to end of pipe without deductions for diameter of manholes. Pipe will be paid for at the contract unit price for the number of linear feet of culverts or storm drains placed in the accepted work.

1.2.2 Manholes and Inlets

****
NOTE: Fill brackets with depth requirements.
****

The quantity of manholes and inlets will be measured as the total number of manholes and inlets of the various types of construction, complete with frames and gratings or covers and, where indicated, with fixed side-rail ladders, constructed to the depth of [_____] feet, in the accepted work. The depth of manholes and inlets will be measured from the top of grating or cover to invert of outlet pipe. Manholes and inlets constructed to depths greater than the depth specified above will be paid for as units at the contract unit price for manholes and inlets, plus an additional amount per linear foot for the measured depth beyond a depth of [_____] feet.

1.2.3 Walls and Headwalls

Walls and headwalls will be measured by the number of cubic yards of reinforced concrete, plain concrete, or masonry used in the construction of the walls and headwalls. Wall and headwalls will be paid for at the contract unit price for the number of walls and headwalls constructed in the completed work.

1.2.4 Flared End Sections

Flared end sections will be measured by the unit. Flared end sections will be paid for at the contract unit price for the various sizes in the accepted work.

1.2.5 Sheeting and Bracing

Payment will be made for that sheeting and bracing ordered to be left in place, based on the number of square feet of sheeting and bracing remaining below the surface of the ground.

1.2.6 Rock Excavation

****
NOTE: Reference should be made to other sections of the project specifications, as applicable, or pertinent requirements may be included in this section.
****

Payment will be made for the number of cubic yards of material acceptably excavated, as specified and defined as rock excavation in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, measured in the original position, and computed by allowing actual width of rock excavation with the following limitations: maximum rock excavation width, 30 inches for pipe of 12 inch or less nominal diameter; maximum rock excavation width, 16 inches greater than outside diameter of pipe of more than 12 inch nominal diameter. Measurement will include authorized overdepth excavation. Payment will also include all necessary drilling and blasting, and all incidentals necessary for satisfactory excavation and disposal of authorized rock excavation. No separate payment will be made for backfill material required to replace rock excavation; this cost shall be included in the Contractor's unit price bid per cubic yard for rock excavation. In rock excavation for manholes and other appurtenances, 1 foot will be allowed outside the wall lines of the structures.

1.2.7 Backfill Replacing Unstable Material

Payment will be made for the number of cubic yards of select granular material required to replace unstable material for foundations under pipes or drainage structures, which will constitute full compensation for this backfill material, including removal and disposal of unstable material and all excavating, hauling, placing, compacting, and all incidentals necessary to complete the construction of the foundation satisfactorily.

1.2.8 Pipe Placed by Jacking

Payment will be made for the number of linear feet of jacked pipe accepted in the completed work measured along the centerline of the pipe in place.

1.3 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

Placing Pipe; [_____].

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

SD-13 Certificates

Resin Certification; [_____]. Pipeline Testing; [_____]. Hydrostatic Test on Watertight Joints; [_____]. Determination of Density; [_____]. Frame and Cover for Gratings; [_____].

Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed. Certification on the ability of frame and cover or gratings to carry the imposed live load.

SD-14 Samples

Pipe for Culverts and Storm Drains; [_____].

Samples of the following materials, before work is started: [_____].

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.4.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2   PRODUCTS

2.1   PIPE FOR CULVERTS AND STORM DRAINS

****

NOTE: The type or types of pipe to be used should be indicated on the drawings. Where the type of pipe is to be the Contractor's option, the types (with size, class, shape, strength, sheet thickness, or gauge) that are acceptable should be listed. The inapplicable types of pipe will be deleted. In specifying plastic, clay, and concrete pipe or aluminum alloy and steel pipe for culverts and storm drains, pipe of comparable strength for the various sizes should be specified.

Where economically feasible or required by special conditions, cast iron soil pipe meeting the requirements of ASTM A 74 may be used for culverts and storm drains. The pipe class, the type of joint, and installation procedures should be as specified in Section 02531 SANITARY SEWERS and Section 02532 FORCE MAINS AND INVERTED SIPHONS; SEWER.

****

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

2.1.1   Concrete Pipe

****

NOTE: The various classes designate different D-loads. D-load is defined as the minimum required three-edge test load on a pipe to produce a 0.01 inch crack and/or ultimate failure in pounds per linear foot per foot (no metric definition) of inside diameter.

Where sulfate-resistant pipe is required and concrete pipe is to be an option, the use of Type II or Type V cement will be specified.

****

ASTM C 76, Class [I] [II] [III] [IV] [V], or ASTM C 655, [_____] D-Load.

2.1.1.1   Reinforced Arch Culvert and Storm Drainpipe

ASTM C 506, Class [A-II] [A-III] [A-IV].

2.1.1.2   Reinforced Elliptical Culvert and Storm Drainpipe

ASTM C 507. Horizontal elliptical pipe shall be Class [HE-A] [HE-I] [HE-II] [HE-III] [HE-IV]. Vertical elliptical pipe shall be Class [VE-II] [VE-III] [VE-IV] [VE-V] [VE-VI].

2.1.1.3   Nonreinforced Pipe

ASTM C 14, Class [1] [2] [3].

2.1.1.4   Cast-In-Place Nonreinforced Conduit

****
NOTE: This type conduit should not be used beneath structures, for drain crossings, adjacent to paved areas, or under high fills.
****

ACI 346/346R, except that testing shall be the responsibility of and at the expense of the Contractor. In the case of other conflicts between ACI 346/346R and project specifications, requirements of ACI 346/346R shall govern.

2.1.2   Clay Pipe

Standard or extra strength, as indicated, conforming to ASTM C 700.

2.1.3   Corrugated Steel Pipe

****
NOTE: The several different metallic coatings may not provide equal protection of the base metal against corrosion and /or abrasion in all environments. Some environments may be so severe that none of the metallic coatings included in this guide specification will provide adequate protection. Additional protection for corrugated steel pipe may be provided by use of bituminous coatings applied after fabrication of the pipe as described in ASTM A 849.

Select option IA or IIA when the polymer precoating, providing extra protection of the base metal against corrosion and/or abrasion in addition to that provided by the metallic coating, is warranted. Some severe environments may cause corrosion problems to accessory items such as rivets or coupling band hardware that do not have a polymer coating.

In addition, paragraphs dealing with Pipe Arches and Arches must be amended to include "concrete" as well as "asphalt" lining or paving damage. Damage to chipped or spalled concrete linings should be repaired in accordance with the manufacturer's recommendations.

Other newly-developed products may be included subject to approval, on a case-by-case basis, by HQUSACE (CEMP-ET) Washington, DC 20314-1000.

Sheet thickness and corrugation size shall be as indicated.
****

ASTM A 760/A 760M, [zinc coated] [aluminum coated] [aluminum-zinc alloy coated] pipe of either:

a. Type [I] [II] pipe with [annular] [helical] corrugations.

b. Type [IA] [IIA] pipe with helical corrugations fabricated with a smooth steel liner of Type C precoated sheet with a polymeric coating on both sides of not less than 0.010 inch thick conforming to ASTM A 742/A 742M.

c. Type [IR] [IIR] pipe with helical corrugations.

2.1.3.1 Fully Bituminous Coated

AASHTO M 190 Type A and ASTM A 760/A 760M [zinc coated] [aluminum coated] [aluminum-zinc alloy coated] pipe of either:

a. Type [I] [II] pipe with [annular] [helical] corrugations.

b. Type [IA] [IIA] pipe with helical corrugations fabricated with a smooth steel liner of Type C precoated sheet with a polymeric coating on both sides of not less than 0.010 inch thick conforming to ASTM A 742/A 742M. Bituminous coating shall only be applied to the outside surface of the shell and the inside surface of the liner.

c. Type [IR] [IIR] pipe with helical corrugations.

2.1.3.2 Half Bituminous Coated, Part Paved

AASHTO M 190 Type B and ASTM A 760/A 760M [zinc coated] [aluminum coated] [aluminum-zinc alloy coated] pipe of either:

a. Type [I] [II] pipe with [annular] [helical] corrugations.

b. Type [IA] [IIA] pipe with helical corrugations fabricated with a smooth steel liner of Type C precoated sheet with a polymeric coating on both surfaces of liner of not less than 0.010 inch thick conforming to ASTM A 742/A 742M. Bituminous coating shall be applied to the outside surface of the shell and the inside surface of the liner.

c. Type [IR] [IIR] pipe with helical corrugations.

2.1.3.3 Fully Bituminous Coated, Part Paved

AASHTO M 190 Type C and ASTM A 760/A 760M [zinc coated] [aluminum coated] [aluminum-zinc alloy coated] pipe of either:

a. Type [I] [II] pipe with [annular] [helical] corrugations.

b. Type [IA] [IIA] pipe with helical corrugations fabricated with a smooth steel liner of Type C precoated sheet with a polymeric coating on both surfaces of liner of not less than 0.010 inch thick conforming to ASTM A 742/A 742M. Bituminous coating shall be applied to the outside surface of the shell and the inside surface of the liner.

c. Type [IR] [IIR] pipe with helical corrugations.

2.1.3.4 Fully Bituminous Coated, Fully Paved

AASHTO M 190 Type D and ASTM A 760/A 760M [zinc coated] [aluminum coated] [aluminum-zinc alloy coated] Type [I] [II], [IR] [IIR] corrugated steel pipe with [annular] [helical] corrugations.

2.1.3.5 Concrete-Lined

****

NOTE: Concrete-lined corrugated metal pipe has recently been approved for use in storm-drainage systems. This product combines the structural economy of corrugated metal pipe with the hydraulic efficiency of a concrete lining to provide an alternative to reinforced concrete pipe.

ASTM A 849 for corrugated steel pipe should be carefully examined. Smooth-lined corrugated pipe and pipe arch will not be given hydraulic credit for the lining unless it can be demonstrated that the lining will last for the full service life of the project. If the lining will last for the full service life, use the same "n" value as for concrete pipe. If the lining will not last the full service life, use the "n" value for uncoated corrugated pipe or pipe arch.

****

ASTM A 760/A 760M zinc coated Type I corrugated steel pipe with [annular] [helical] corrugations and a concrete lining in accordance with ASTM A 849. The concrete lining shall be not less than 3/8 inch over the inside crest of the corrugation.

2.1.3.6 Precoated

ASTM A 762/A 762M corrugated steel pipe fabricated from ASTM A 742/A 742M Grade [10/0] [10/10] of either:

a. Type [I] [II] pipe with [annular] [helical] corrugations.

b. Type [IA] [IR] [IIA] [IIR] pipe with helical corrugations.

2.1.3.7 Precoated, Part Paved

ASTM A 762/A 762M corrugated steel pipe and AASHTO M 190 Type B (modified), paved invert only, fabricated from ASTM A 742/A 742M Grade [10/0] [10/10] precoated sheet of either:

a. Type [I] [II] pipe with [annular] [helical] corrugations.

b. Type [IA] [IR] [IIA] [IIR] pipe with helical corrugations.

2.1.3.8 Precoated, Fully Paved

ASTM A 762/A 762M Type [I] [II] [IR] [IIR] corrugated steel pipe and AASHTO M 190 Type D (modified), fully paved only, fabricated from ASTM A 742/A 742M Grade [10/0] [10/10] precoated sheet and [annular] [helical] corrugations.

2.1.4 Corrugated Aluminum Alloy Pipe

****
NOTE: Coordinate with paragraph Corrugated Steel Pipe.
****

ASTM B 745/B 745M corrugated aluminum alloy pipe of either:

a. Type [I] [II] pipe with [annular] [helical] corrugations.

b. Type [IA] [IR] [IIA] [IIR] pipe with helical corrugations.

2.1.4.1 Aluminum Fully Bituminous Coated

AASHTO M 190 Type A and ASTM B 745/B 745M corrugated aluminum alloy pipe of either:

a. Type [I] [II] pipe with [annular] [helical] corrugations.

b. Type [IA] [IR] [IIA] [IIR] pipe with helical corrugations.

2.1.4.2 Aluminum Fully Bituminous Coated, Part Paved

AASHTO M 190 Type C and ASTM B 745/B 745M corrugated aluminum alloy pipe of either:

a. Type [I] [II] pipe with [annular] [helical] corrugations.

b. Type [IR] [IIR] pipe with helical corrugations.

2.1.5 Structural Plate, Steel Pipe, Pipe Arches and Arches

****
NOTE: Coordinate with paragraph Corrugated Steel Pipe.

This paragraph includes options for providing a protective coating on the structural plate pipe. The designer will delete these options when protective coating is not a part of the project requirements. When protective coating on the structural-plate pipe is a project requirement, the designer will select the applicable option. Metal pipe manufacturers state that it is impracticable in initial construction to provide a permanent paved invert of bituminous material in structural-plate corrugated metal pipe.
****

Assembled with galvanized steel nuts and bolts, from galvanized corrugated steel plates conforming to AASHTO M 167. Pipe coating, when required, shall conform to the requirements of [AASHTO M 190 Type A] [AASHTO M 243]. Thickness of plates shall be as indicated.

2.1.6   Structural Plate, Aluminum Pipe, Pipe Arches and Arches

****

NOTE: Coordinate with paragraph Corrugated Steel Pipe and paragraph Structural Plate, Steel Pipe, Pipe Arches and Arches.

****

Assembled with either aluminum alloy, aluminum coated steel, stainless steel or zinc coated steel nuts and bolts. Nuts and bolts, and aluminum alloy plates shall conform to AASHTO M 219. Pipe coating, when required, shall conform to the requirements of [AASHTO M 190, Type A] [AASHTO M 243]. Thickness of plates shall be as indicated.

2.1.7   Ductile Iron Culvert Pipe

ASTM A 716.

2.1.8   PVC Pipe

The pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe, shall be submitted prior to installation of the pipe.

2.1.8.1   Type PSM PVC Pipe

ASTM D 3034, Type PSM, maximum SDR 35, produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.8.2   Profile PVC Pipe

ASTM F 794, Series 46, produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.8.3   Smooth Wall PVC Pipe

ASTM F 679 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.8.4   Corrugated PVC Pipe

ASTM F 949 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.9   PE Pipe

The pipe manufacturer's resin certification indicating the cell classification of PE used to manufacture the pipe shall be submitted prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D 3350.

2.1.9.1   Smooth Wall PE Pipe

ASTM F 714, maximum DR of 21 for pipes 3 to 24 inches in diameter and maximum DR of 26 for pipes 26 to 48 inches in diameter. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 335434C.

2.1.9.2 Corrugated PE Pipe

****
NOTE: Corrugated PE pipe culverts and storm drains shall not be installed beneath airfield pavements, Class A, B, or C roads, or road pavements with a design index of 6 or greater. Type S pipe has a full circular cross-section, with an outer corrugated pipe wall and a smooth inner liner. Type C pipe has a full circular cross-section, with a corrugated surface both inside and outside. Corrugations may be either annular or helical.
****

AASHTO M 294, Type S, for pipes 12 to 36 inches and AASHTO MP6, Type S or D, for pipes 42 to 48 inches produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 315412C or 324420C. Pipe walls shall have the following properties:

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment of Inertia of Wall Section (in to the 4th/in)
12	1.50	0.024
15	1.91	0.053
18	2.34	0.062
24	3.14	0.116
30	3.92	0.163
36	4.50	0.222
42	4.69	0.543
48	5.15	0.543

2.1.9.3 Profile Wall PE Pipe

ASTM F 894, RSC 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 334433C. Pipe walls shall have the following properties:

		Minimum Moment Of Inertia of Wall Section (in to the 4th/in)	
Nominal Size (in.)	Minimum Wall Area (square in/ft)	Cell Class 334433C	Cell Class 335434C
18	2.96	0.052	0.038
21	4.15	0.070	0.051
24	4.66	0.081	0.059

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment Of Inertia of Wall Section (in to the 4th/in) Cell Class 334433C	Cell Class 335434C
27	5.91	0.125	0.091
30	5.91	0.125	0.091
33	6.99	0.161	0.132
36	8.08	0.202	0.165
42	7.81	0.277	0.227
48	8.82	0.338	0.277

2.2 DRAINAGE STRUCTURES

2.2.1 Flared End Sections

Sections shall be of a standard design fabricated from zinc coated steel sheets meeting requirements of ASTM A 929/A 929M.

2.2.2 Precast Reinforced Concrete Box

****

NOTE: Where sulfate-resistant pipe is required and concrete pipe is to be an option, the use of Type II or Type V cement will be specified.

****

For highway loadings with 2 feet of cover or more or subjected to dead load only, ASTM C 789; for less than 2 feet of cover subjected to highway loading, ASTM C 850.

2.3 MISCELLANEOUS MATERIALS

****

NOTE: The details indicating size, shape, materials, thickness of various sections, the finish required, and amounts of reinforcing, if any, for catch basins, inlets, walls, headwalls, and manholes should be shown on the drawings. Also, the shape, size, thickness of sections, kinds of materials, and weights for frames, covers, and gratings for inlets and manholes, as well as the amount of waterway opening for inlets and gratings should be indicated on the drawings. The covers and gratings should be designed to have ample strength for the traffic conditions to which they may be subjected. Fixed, straight-type galvanized steel ladders should be provided for manholes over 3.66 m (12 feet) deep measured form top of grate to invert of outlet pipe.

****

2.3.1 Concrete

****
NOTE: Reference should be made to other sections of the project specifications, as applicable, or pertinent requirements may be included in this section.

The air contents specified are for concrete that will be subjected to freezing weather and the possible action of deicing chemicals. In climates where freezing is not a factor but where air entrainment is used in local commercial practice to improve the workability and placability of concrete, concrete having air content of 4-1/2 plus or minus 1-1/2 percent may be specified as Contractor's option to nonairentrained concrete.
****

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for [_____] psi concrete under Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall not be less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between steel and ground. Expansion-joint filler material shall conform to ASTM D 1751, or ASTM D 1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

2.3.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C 270, Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar but in no case shall exceed [_____] gallons of water per sack of cement. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

2.3.3 Precast Concrete Segmental Blocks

Precast concrete segmental block shall conform to ASTM C 139, not more than 8 inches thick, not less than 8 inches long, and of such shape that joints can be sealed effectively and bonded with cement mortar.

2.3.4 Brick

Brick shall conform to ASTM C 62, Grade SW; ASTM C 55, Grade S-I or S-II; or ASTM C 32, Grade MS. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement.

The joints shall be filled completely and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with 1/2 inch of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course. For round structures, brick shall be laid radially with every sixth course a stretcher course.

2.3.5   Precast Reinforced Concrete Manholes

****
NOTE: Rubber-type gasket joints should be specified only where watertightness is essential.
****

Precast reinforced concrete manholes shall conform to ASTM C 478. Joints between precast concrete risers and tops shall be [full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure] [made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph JOINTS].

2.3.6   Prefabricated Corrugated Metal Manholes

Manholes shall be of the type and design recommended by the manufacturer. Manholes shall be complete with frames and cover, or frames and gratings.

2.3.7   Frame and Cover for Gratings

****
NOTE: The likelihood of bicycle traffic should be considered in the selection of the type of inlet cover configuration.
****

Frame and cover for gratings shall be cast gray iron, ASTM A 48, Class 35B; cast ductile iron, ASTM A 536, Grade 65-45-12; or cast aluminum, ASTM B 26/B 26M, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.

2.3.8   Joints

2.3.8.1   Flexible Watertight Joints

****
NOTE: This paragraph covers compression-type rubber-gasketed joints. When pipe requiring a pressure-type joint is specified, the requirements of this paragraph may not apply and the joint should be made in accordance with the specifications for the pipe.
****

a. Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M 198, and rubber-type gaskets shall conform to ASTM C 443. Factory-fabricated resilient joint materials shall conform to ASTM C 425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches.

b. Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C 443. Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.

2.3.8.2 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C 877.

2.3.8.3 Flexible Watertight, Gasketed Joints

****

NOTE: The inapplicable type of gasket material should be deleted. Type 2A1 should be specified where specific resistance to the action of petroleum base oils is not required. Type 2B3 has specific requirements for oil resistance with low swell. Fill in blank for any other combination of Class and Grade required.

****

a. Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 7 inches wide and approximately 3/8 inch thick, meeting the requirements of ASTM D 1056, Type 2 [A1] [B3] [_____], and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D 1171. Rubber O-ring gaskets shall be 13/16 inch in diameter for pipe diameters of 36 inches or smaller and 7/8 inch in diameter for larger pipe having 1/2 inch deep end corrugation. Rubber O-ring gaskets shall be 1-3/8 inches in diameter for pipe having 1 inch deep end corrugations. O-rings shall meet the requirements of AASHTO M 198 or ASTM C 443. Flexible plastic gaskets shall conform to requirements of AASHTO M 198, Type B.

b. Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.

2.3.8.4 PVC Plastic Pipes

Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

2.3.8.5 Smooth Wall PE Plastic Pipe

Pipe shall be joined using butt fusion method as recommended by the pipe manufacturer.

2.3.8.6 Corrugated PE Plastic Pipe

Water tight joints shall be made using a PVC or PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall conform to ASTM F 477. Soil tight joints shall conform to the requirements in AASHTO HB-16, Division II, Section 26.4.2.4. (e) for soil tightness and shall be as recommended by the pipe manufacturer.

2.3.8.7 Profile Wall PE Plastic Pipe

Joints shall be gasketed or thermal weld type with integral bell in accordance with ASTM F 894.

2.3.8.8 Ductile Iron Pipe

Couplings and fittings shall be as recommended by the pipe manufacturer.

2.4 STEEL LADDER

Steel ladder shall be provided where the depth of the manhole exceeds 12 feet. These ladders shall be not less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers shall be a minimum 3/8 inch thick and 2-1/2 inches wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123/A 123M.

2.5 DOWNSPOUT BOOTS

Boots used to connect exterior downspouts to the storm-drainage system shall be of gray cast iron conforming to ASTM A 48, Class 30B or 35B. Shape and size shall be as indicated.

2.6 HYDROSTATIC TEST ON WATERTIGHT JOINTS

****

NOTE: When the quantity of pipe required for a project is so small that the provisions for testing and certification of watertightness of joints appears to be economically unfeasible, such provisions should be deleted.

****

2.6.1 Concrete, Clay, PVC and PE Pipe

A hydrostatic test shall be made on the watertight joint types as proposed. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to AASHTO M 198 or ASTM C 443. Test requirements for joints in clay pipe shall conform to ASTM C 425. Test requirements for joints in PVC and PE plastic pipe shall conform to ASTM D 3212.

2.6.2 Corrugated Steel and Aluminum Pipe

****

NOTE: The pipe length tested for hydrostatic test on joints must not exceed the "Allowable span in feet for CSP Flowing Full," TABLE 3-4, of American Iron and Steel Institute Publication "Handbook of Steel Drainage and Highway Construction Products". The joint is in the center of the sample tested, the supports should be at 21 percent of the sample length from the ends of the sample to develop 15 percent moment when filled with water.

****

A hydrostatic test shall be made on the watertight joint system or coupling band type proposed. The moment strength required of the joint is expressed as 15 percent of the calculated moment capacity of the pipe on a transverse section remote from the joint by the AASHTO HB-16 (Division II, Section 26). The pipe shall be supported for the hydrostatic test with the joint located at the point which develops 15 percent of the moment capacity of the pipe based on the allowable span in feet for the pipe flowing full or 40,000 foot-pounds, whichever is less. Performance requirements shall be met at an internal hydrostatic pressure of 10 psi for a 10 minute period for both annular corrugated metal pipe and helical corrugated metal pipe with factory reformed ends.

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

****

NOTE: Reference should be made to other sections of the project specifications, as applicable, or pertinent requirements may be included in this section.

****

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of [Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS] [and] [Section 02300 EARTHWORK] and the requirements specified below.

3.1.1 Trenching

****

NOTE: Economic considerations should determine the width of trench to be used in the design analysis and to be specified for construction. Where it is more economical to control trench width and thereby use less costly pipe, the width of the trench shall vary with the pipe diameter and should be held to a minimum consistent with the space required for proper installation of the pipe and the backfill at the sides of the pipe. Where the sides of the

excavations are to be supported, proper allowance should be made for the space occupied by the sheeting and bracing.
****

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus [_____] inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified. Contractor shall not overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

3.1.2   Removal of Rock

****
NOTE: Unless otherwise specified, material used to replace unstable material or rock excavation should be compacted to a minimum density of 90 percent for cohesive soils and 95 percent for noncohesive soils, as determined by ASTM D 1557.
****

Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.1.3   Removal of Unstable Material

****
NOTE: Coordinate with preceding paragraph.
****

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor in his performance of shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the government.

3.2   BEDDING

****
NOTE: It should be noted that pipe cover requirements will be different for different types of bedding.

****

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

3.2.1 Concrete Pipe Requirements

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be not more than the length, depth, and width required for properly making the particular type of joint.

3.2.2 Clay Pipe Requirements

Bedding for clay pipe shall be as specified by ASTM C 12.

3.2.3 Corrugated Metal Pipe

Bedding for corrugated metal pipe and pipe arch shall be in accordance with ASTM A 798/A 798M. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, the Contractor shall either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Bedding for corrugated structural plate pipe shall meet requirements of ASTM A 807.

3.2.4 Ductile Iron Pipe

Bedding for ductile iron pipe shall be as shown on the drawings.

3.2.5 Plastic Pipe

Bedding for PVC and PE pipe shall meet the requirements of ASTM D 2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.

3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Corrugated Steel and Aluminum Alloy	5

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Concrete-Lined Corrugated Steel	3
Ductile Iron Culvert	3
Plastic	7.5

Not less than 30 days after the completion of backfilling, the Government may perform a deflection test on the entire length of installed flexible pipe using a mandrel or other suitable device. Installed flexible pipe showing deflections greater than those indicated above shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced at no cost to the Government.

3.3.1 Concrete, Clay, PVC, Ribbed PVC and Ductile Iron Pipe

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

3.3.2 Elliptical and Elliptical Reinforced Concrete Pipe

The manufacturer's reference lines, designating the top of the pipe, shall be within 5 degrees of a vertical plane through the longitudinal axis of the pipe, during placement. Damage to or misalignment of the pipe shall be prevented in all backfilling operations.

3.3.3 Corrugated PE Pipe

Laying shall be with the separate sections joined firmly on a bed shaped to line and grade and shall follow manufacturer's recommendations.

3.3.4 Corrugated Metal Pipe and Pipe Arch

****

NOTE: Coordinate with paragraph Corrugated Steel Pipe.

****

Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Part paved pipe shall be installed so that the centerline of bituminous pavement in the pipe, indicated by suitable markings on the top at each end of the pipe sections, coincides with the specified alignment of pipe. Fully paved steel pipe or pipe arch shall have a painted or otherwise applied label inside the pipe or pipe arch indicating sheet thickness of pipe or pipe arch. Any unprotected metal in the joints shall be coated with bituminous material as specified in AASHTO M 190 or AASHTO M 243. Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During installation, pipe or pipe arch shall be handled with care to preclude damage to the bituminous coating or paving. Prior to placing backfill, damaged areas of coupling bands and pipe shall be given a coating of bituminous material, as specified in AASHTO M 190 or AASHTO M 243. Pipe on which bituminous coating has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced.

Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.

3.3.5 Structural-Plate Steel

Structural plate shall be installed in accordance with ASTM A 807. Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are tightened to meet the torque requirements of 200 foot-pounds plus or minus 50 foot-pounds. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for amount of torque produced. Power wrenches shall be checked and adjusted frequently as needed, according to type or condition, to ensure proper adjustment to supply the required torque.

3.3.6 Structural-Plate Aluminum

Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are torqued to a minimum of 100 foot-pounds on aluminum alloy bolts and a minimum of 150 foot-pounds on galvanized steel bolts. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for the amount of torque produced. Power wrenches shall be checked and adjusted as frequently as needed, according to type or condition, to ensure that they are in proper adjustment to supply the required torque.

3.3.7 Multiple Culverts

****

NOTE: Where encasement or other special conditions are specified, minimum spacing as specified in this paragraph should not apply.

****

Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 3 feet apart, whichever is less.

3.3.8 Jacking Pipe Through Fills

Methods of operation and installation for jacking pipe through fills shall conform to requirements specified in Volume 1, Chapter 1, Part 4 of AREA-01.

3.4 JOINTING

****

NOTE: Where watertightness is not required, watertight and at least one other type of joint should be included for each type of pipe required. Where watertightness is essential, delete paragraphs Cement-Mortar Bell-and-Spigot Joint through Plastic

Sealing Compound Joints for Tongue-and-Grooved Pipe below.

****

3.4.1 Concrete and Clay Pipe

3.4.1.1 Cement-Mortar Bell-and-Spigot Joint

The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be thoroughly cleaned with a wet brush and the lower portion of the bell filled with mortar as required to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into a bell so that sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.

3.4.1.2 Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe

A closely twisted gasket shall be made of jute or oakum of the diameter required to support the spigot end of the pipe at the proper grade and to make the joint concentric. Joint packing shall be in one piece of sufficient length to pass around the pipe and lap at top. This gasket shall be thoroughly saturated with neat cement grout. The bell of the pipe shall be thoroughly cleaned with a wet brush, and the gasket shall be laid in the bell for the lower third of the circumference and covered with mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted in the bell, and carefully driven home. A small amount of mortar shall be inserted in the annular space for the upper two-thirds of the circumference. The gasket shall be lapped at the top of the pipe and driven home in the annular space with a caulking tool. The remainder of the annular space shall be filled completely with mortar and beveled at an angle of approximately 45 degrees with the outside of the bell. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. Placing of this type of joint shall be kept at least five joints behind laying operations.

3.4.1.3 Cement-Mortar Diaper Joint for Bell-and-Spigot Pipe

The pipe shall be centered so that the annular space is uniform. The annular space shall be caulked with jute or oakum. Before caulking, the inside of the bell and the outside of the spigot shall be cleaned.

a. Diaper Bands: Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut in lengths that extend one-eighth of the circumference of pipe above the spring line on one side of the pipe and up to the spring line on the other side of the pipe. Longitudinal edges of fabric bands shall be rolled and stitched around two pieces of wire. Width of fabric bands shall be such that after fabric has been securely stitched around both edges on wires, the wires will be uniformly spaced not less than 8 inches apart. Wires shall be cut into lengths to pass around pipe with sufficient extra length for the ends to be twisted at top of pipe to hold the band securely in place; bands shall be accurately centered around lower portion of joint.

b. Grout: Grout shall be poured between band and pipe from the high side of band only, until grout rises to the top of band at the spring line of pipe, or as nearly so as possible, on the opposite side of pipe, to ensure a thorough sealing of joint around the portion of pipe covered by the band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be forced out by pouring, and removed.

c. Remainder of Joint: The remaining unfilled upper portion of the joint shall be filled with mortar and a bead formed around the outside of this upper portion of the joint with a sufficient amount of additional mortar. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind actual laying of pipe. No backfilling around joints shall be done until joints have been fully inspected and approved.

3.4.1.4 Cement-Mortar Tongue-and-Groove Joint

The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The grooved end of the first pipe shall be thoroughly cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe shall be inserted in the grooved end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside.

3.4.1.5 Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe

The joint shall be of the type described for cement-mortar tongue-and-groove joint in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 1/2 inch, thick and the width of the diaper band shall be at least 8 inches. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. Backfilling around the joints shall not be done until the joints have been fully inspected and approved.

3.4.1.6 Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe

Sealing compounds shall follow the recommendation of the particular manufacturer in regard to special installation requirements. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint with mastic-type sealant, a slight protrusion of the material is not visible along the entire inner and outer circumference of the joint when the joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions shall be cut off flush with the inner surface of the pipe. If nonmastic-type sealant material is used, the "Squeeze-Out" requirement above will be waived.

3.4.1.7 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

3.4.1.8 External Sealing Band Joint for Noncircular Pipe

Surfaces to receive sealing bands shall be dry and clean. Bands shall be installed in accordance with manufacturer's recommendations.

3.4.2 Corrugated Metal Pipe

3.4.2.1 Field Joints

****

NOTE: Delete this paragraph where watertightness is essential.

****

Transverse field joints shall be designed so that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in ASTM A 798/A 798M. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. The annular space between abutting sections of part paved, and fully paved pipe and pipe arch, in sizes 30 inches or larger, shall be filled with a bituminous material after jointing. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. The type, size, and sheet thickness of the band and the size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or specifications for the pipe.

3.4.2.2 Flexible Watertight, Gasketed Joints

Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened. Band Tightening: The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket; the gasket shall seat properly in the corrugations. Watertight joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

3.5 DRAINAGE STRUCTURES

****

NOTE: Coordinate with paragraph MISCELLANEOUS MATERIALS.

****

3.5.1 Manholes and Inlets

****

NOTE: Prepare the required paragraph or section covering the essential requirements for reinforced concrete inlet construction and insert the required reference to the paragraph or section prepared to cover these items.

****

Construction shall be of reinforced concrete, plain concrete, brick, precast reinforced concrete, precast concrete segmental blocks, prefabricated corrugated metal, or bituminous coated corrugated metal; complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated. Pipe studs and junction chambers of prefabricated corrugated metal manholes shall be fully bituminous-coated and paved when the connecting branch lines are so treated.

3.5.2 Walls and Headwalls

****

NOTE: Dry-stone masonry may be specified and used for crib construction and/or sloping retaining walls that will sustain little or no earth pressure.

****

Construction shall be as indicated.

3.6 STEEL LADDER INSTALLATION

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet vertically, and shall be installed to provide at least 6 inches of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

3.7 BACKFILLING

****
NOTE: The thickness of layers of backfill and the degree of compaction required to prevent undesirable settlement should be determined by soil conditions and the job compaction requirements. When rigid pipe is to be placed under high fills, the imperfect trench method of installation may be specified.
****

3.7.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding [_____] inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.7.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding [_____] inches.

3.7.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.7.4 Compaction

3.7.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.7.4.2 Minimum Density

****

NOTE: For culverts or storm drains installed beneath structures (including embankments) that have critical stability requirements or settlement limitations, the maximum density requirements should be increased as necessary. If only a cohesive soil or only a cohesionless material will be used as backfill, the inapplicable value will be deleted.

****

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

a. Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.

b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.

c. Under nontraffic areas, density shall be not less than that of the surrounding material.

3.7.5 Determination of Density

Testing shall be the responsibility of the Contractor and performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D 1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D 2167 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017 or ASTM D 2922. Test results shall be furnished the Contracting Officer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

3.8 PIPELINE TESTING

****

NOTE: When the quantity of pipe required for a project is so small that the provisions for testing and certification of watertightness of joints appears to be economically unfeasible, such provisions should be deleted.

Select appropriate leakage rate.

Delete paragraph when watertight joints are not required.

****

Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate. Low pressure air testing for vitrified clay pipes shall conform to ASTM C 828. Low pressure air testing for concrete pipes shall conform to ASTM C 924. Low pressure air testing for plastic pipe shall conform to ASTM F 1417. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C 828 or ASTM C 924, after consultation with the pipe manufacturer. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C 1103. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed[250 gallons per inch in diameter per mile of pipeline per day] [0.2 gallons per inch in diameter per 100 feet of pipeline per hour]. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correcting, and retesting shall be made at no additional cost to the Government.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02711 (March 1998)**
U.S. ARMY CORPS OF ENGINEERS **--------------------------**
Superseding
CEGS-02239 (February 1989)

GUIDE SPECIFICATION FOR CONSTRUCTION

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02711

PORTLAND CEMENT-STABILIZED BASE OR SUBBASE COURSE
03/98

****
NOTE: This guide specification covers the requirements for portland cement-stabilized base or subbase and lean concrete bases or subbases. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: In general, this specification is written for portland cement-stabilized base or subbase courses and is applicable to lean concrete bases or subbases (also popularly known as "Econocrete") since materials and construction procedures are similar. The lean concrete base may or may not require sawcut construction joints depending on the engineer's purpose in using the base and the planned surfacing construction. Generally, all longitudinal construction joints are butt joints without keys, dowels, or tie bars. Lean concrete base differs from conventional paving concrete primarily due to lower cement contents. Sometimes a poorer quality aggregate may be used but the durability of this

aggregate under the project's freezing and thawing conditions should be investigated. Other considerations such as popouts or easily polished aggregates are of less concern in a base than in a surface pavement. Aggregate quality requirements may be relaxed for these considerations. The dividing line between a portland cement-stabilized base or subbase and lean concrete base or subbase is not clear. Generally, if the material's compressive strength is less than 10 MPa (1500 psi), the flexural strength is less than 2.5 MPa (350 psi), or the amount of material passing the 0.075 mm (No. 200) sieve is allowed to increase appreciably, it should be treated as a stabilized base or subbase rather than lean concrete base or subbase.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 81	(1992) Cut-Back Asphalt (Rapid-Curing Type)
AASHTO M 82	(1975) Cut-Back Asphalt (Medium-Curing Type)
AASHTO M 147	(1965) Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses
AASHTO M 182	(1991) Burlap Cloth Made from Jute or Kenaf
AASHTO T 134	(1993) Moisture-Density Relations of Soil-Cement Mixtures
AASHTO T 135	(1992) Wetting-and-Drying Test of Compacted Soil-Cement Mixtures
AASHTO T 136	(1992) Freezing-and-Thawing Tests of Compacted Soil-Cement Mixtures

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates

ASTM C 150	(1996) Portland Cement
ASTM C 171	(1997) Sheet Materials for Curing Concrete
ASTM C 595	(1995a) Blended Hydraulic Cements
ASTM C 595M	(1995a) Blended Hydraulic Cements (Metric)
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 490	(1992) Road Tar
ASTM D 558	(1996) Moisture-Density Relations of Soil-Cement Mixtures
ASTM D 559	(1996) Wetting and Drying Compacted Soil-Cement Mixtures
ASTM D 560	(1996) Freezing and Thawing Compacted Soil-Cement Mixtures
ASTM D 633	(1987; R 1991) Volume Correction Table for Road Tar
ASTM D 977	(1991) Emulsified Asphalt
ASTM D 1241	(1968; R 1994) Materials for Soil-Aggregate Subbase, Base, and Surface Courses
ASTM D 1250	(1980; R 1990) Petroleum Measurement Tables
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft.(2,700 kN-m/cu. m.))
ASTM D 1632	(1996) Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory
ASTM D 1633	(1996) Compressive Strength of Molded Soil-Cement Cylinders
ASTM D 2027	(1976; R 1992) Cutback Asphalt (Medium-Curing Type)
ASTM D 2028	(1976; R 1992) Cutback Asphalt (Rapid-Curing Type)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock In Place by Nuclear Methods (Shallow Depth)
ASTM D 4318	(1995a) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes

1.2 UNIT PRICES

1.2.1 Measurement

****

NOTE: This paragraph will be deleted when lump-sum payment is desired.

Method of measurement not applicable to the job conditions will be deleted. If bituminous material is to be paid for separately, select the desired method of measurement. Reference to select material will be deleted when select material is not required from borrow areas.

****

1.2.1.1 Portland Cement Stabilization

Measurement shall be by the square yard of work completed and accepted.

1.2.1.2 Cement

Measurement shall be by the number of short hundred-weight (cwt) of cement used in the completed and accepted work. No measurement shall be made for wasted cement or cement used in work determined defective.

1.2.1.3 Bituminous Material

Bituminous material to be paid for shall be measured by the number of [gallons of the material used in the accepted work, corrected to gallons at 60 degrees F in accordance with [ASTM D 633] [ASTM D 1250]. A coefficient of 0.00025 per degree F shall be used for asphalt emulsion] [2000 pound tons of the material used in the accepted work].

1.2.1.4 Select Material

Select material shall be measured by the [cubic yard] [2000 pound ton] of material placed and used in the completed and accepted stabilization. No measurement will be made for select material that is wasted or used in work determined defective.

1.2.2 Payment

****

NOTE: Paragraph will be deleted when select material is not required or when small quantities do not justify the inclusion of select material.

Delete material in the first set of brackets when onsite material is not available.

Reference to select material will be deleted when select material is not required from borrow areas.

The last sentence in brackets will be deleted if sanding and dusting of the bituminous-cured surfaces is not required or if bituminous-cured surfaces are to receive bituminous surfacing under the contract.
****

Cement stabilization, constructed and accepted, including cement, [bituminous material] [and select material] will be paid for at the respective contract unit prices in the bidding schedule. No payment will be made for any material wasted, used for the convenience of the Contractor, unused or rejected, or for water used. [Select material obtained from grading and excavation operations at the project site will not be paid for under this section but will be included for payment under other sections specifying grading and excavating.] [No separate payment will be made for sanding or dusting the bituminous prime-coated surfaces, and all costs for sanding or dusting will be included in the contract unit price for bituminous material.]

1.3 DEFINITION

Portland cement-stabilized base or subbase course, as used herein, is a mixture of portland cement and in-place, or select borrow, material uniformly blended and thoroughly compacted to produce a pavement course which meets the criteria set forth in the drawings and specifications.

1.4 WAYBILLS AND DELIVERY TICKETS

****
NOTE: This paragraph will be deleted when lump-sum payment is desired.
****

Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all cement [, bituminous material] [and select material] used in the construction.

1.5 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Mix Design; [_____].

Proposed mix design, prior to start of stabilization work.

SD-09 Reports

Stabilizing Course; [_____].

Certified copies of aggregate test results, not less than [30] [_____] days before the material is required in the work. Calibration curves and related test results, prior to using the device or equipment being calibrated.

SD-13 Certificates

Bituminous Material; [_____].

Certified copies of the manufacturer's test reports indicating compliance with applicable specified requirements, not less than [30] [_____] days before the material is required in the work.

SD-18 Records

Stabilizing Course; [_____].

Notification of sources from which aggregates are to be obtained, within 15 days after the award of contract.

Source of Bituminous Materials; [_____].

Notification of sources from which bituminous materials are to be obtained, within 15 days after the award of the contract.

Waybills and Delivery Tickets; [_____].

Copies during construction. Copies for all material used, before final payment.

1.6 PLANT, EQUIPMENT, MACHINES, AND TOOLS

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required compaction, meeting grade controls, thickness control and smoothness requirements specified. [A test section of at least 8 by 100 feet, utilizing the equipment and procedures proposed for use by the Contractor, shall be placed to demonstrate that soil-cement stabilization conforming to this specification can be produced] [A test section is not required].

1.6.1 Central-Plant

The central plant shall be capable of producing a uniform cement-treated mixture at the required cement and moisture contents. Soil and cement shall be dry-mixed sufficiently to prevent cement balls from forming when water is added.

1.6.2 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one [10] [12] foot straightedge for each bituminous paver, for use in the testing of the finished surface. Straightedges shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

1.7 WEATHER LIMITATIONS

Cement shall not be applied when the atmospheric temperature is less than 40 degrees F. Cement shall not be applied to soils that are frozen or contain frost, or when the underlying material is frozen. If the temperature falls below 35 degrees F, completed cement-treated areas shall be protected against detrimental effects of freezing. Any areas of completed [base] [or] [subbase] that are damaged by freezing, rainfall, or other weather conditions shall be brought to a satisfactory condition in conformance with this specification without additional cost to the Government.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cement

Cement shall conform to ASTM C 150, Type I, IA, II, or IIA or ASTM C 595, Type IS or IS(A).

2.1.2 Bituminous Material

****

NOTE: Tar or asphalt of one grade or type will be specified.

****

Bituminous material shall conform to one of the following:

2.1.2.1 Cutback Asphalt

[AASHTO M 81] [AASHTO M 82] or [ASTM D 2027], [ASTM D 2028], Grade [MC-70] [MC-250] [RC-70] [RC-250].

2.1.2.2 Emulsified Asphalt

ASTM D 977, Type [RS-1] [RS-2].

2.1.2.3 Tar

ASTM D 490, Grade [RT-7] [RT-8] [RT-9] [RT-10].

2.1.3 Material to be Stabilized

****

NOTE: For base courses for airfield pavements delete requirements for in-place materials, traveling plant, and in-place mix method. Specify a select material conforming to AASHTO M 147 or ASTM D 1241 and central plant mixing method.

****

The material to be stabilized shall consist of [in-place material] [select material conforming to AASHTO M 147 or ASTM D 1241, Grading [B] [C] [or] [D]]. Stones retained on a 2 inch sieve and deleterious substances such as sticks, debris, and organic matter shall be removed. When the in-place material consists primarily of soil having high plasticity or otherwise undesirable characteristics, the course shall be constructed to produce fully hardened soil cement as determined by AASHTO T 135 and AASHTO T 136 or ASTM D 559 and ASTM D 560; not more than 45 percent of the material should be retained on the No. 4 sieve.

2.1.4 Water

Water shall be clean, fresh, and free from injurious amounts of oil, acid, salt, alkali, organic matter, and other substances deleterious to the hardening of soil-cement, and shall be subject to approval.

2.1.5 Burlap

Burlap shall conform to AASHTO M 182.

2.1.6 Impervious Sheeting

Sheeting shall conform to ASTM C 171 and shall be white waterproof paper, white opaque polyethylene film or white burlap-polyethylene sheets.

2.2 MIX DESIGN

****

NOTE: Designer should refer to TM 5-822-14 and TM 5-825-2 for further guidance on restrictions to be placed or requirements added to the mix design paragraph, and information on applicability of stabilization with portland cement.

****

Mix shall be developed using the aggregate or soil-aggregate material to be stabilized. Mix shall have a minimum compressive strength of [250 psifor subbase,] [750 psi for base,] [1500 psifor lean concrete,] a weight loss of 14 percent or less after 12 cycles of the durability test, and "low alkali" cement for alkali reactive aggregate.

2.3 SAMPLING AND TESTING

2.3.1 Testing Facilities

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. Work requiring testing will not be permitted until the facilities have been inspected and approved. The first inspection will be at the expense of the Government.

Cost incurred for any subsequent inspection, required because of failure of the facilities to pass the first inspection, shall be charged to the Contractor. Tests shall be performed in sufficient numbers and as specified to ensure that materials and compaction meet specified requirements. Copies of the test results shall be furnished to the Contracting Officer within 24 hours of completion of tests.

2.3.2 Test Results

Results shall verify that materials comply with the specification. When a material source is changed, [the new material shall be tested for compliance] [_____]. When deficiencies are found, the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or repaired to conform to the contract requirements at no additional cost to the Government.

2.3.3 Aggregate

Tests for determining the suitability of aggregate shall include, but not be limited to: sieve analysis in accordance with ASTM C 136, and ASTM D 422 using sieves conforming to ASTM E 11, liquid limits and plasticity index in accordance with ASTM D 4318. Aggregate samples for laboratory tests shall be taken in accordance with ASTM D 75. Specimens to be used for unconfined compression tests shall be prepared in accordance with ASTM D 1632 except that a 4 inch diameter by 8 inch high mold shall be used to prepare specimens when more than 35 percent of the material is retained on the No. 4 sieve.

2.3.4 Initial Sampling and Testing

2.3.4.1 Laboratory Density

Moisture-density tests shall be conducted in accordance with the procedure contained in AASHTO T 134 or ASTM D 558; however the apparatus and procedures outlined in ASTM D 1557 shall be used to compact the soil-cement mixture.

2.3.4.2 Unconfined Compression Testing

Unconfined compression tests shall be conducted in accordance with ASTM D 1633. Three tests shall be conducted for each mix design tested. Samples shall be cured at a constant moisture content and temperature for 7 days.

2.3.4.3 Durability Tests

****

NOTE: Where the soil aggregate mixture is an approved select material conforming to AASHTO M 147 or ASTM D 1241, Grading B, C, or D, the use of the test procedures conforming to AASHTO T 135 and AASHTO T 136 or ASTM D 559 and ASTM D 560 may be waived.

The last sentence in brackets will be deleted if sanding and dusting of the bituminous-cured surfaces is not required or if bituminous-cured surfaces are to receive bituminous surfacing under the contract.

****

[Wet-dry tests shall be conducted in accordance with AASHTO T 135 or ASTM D 559.] [Freeze-thaw tests shall be conducted in accordance with AASHTO T 136 or ASTM D 560.] Three tests shall be conducted for each mix design tested.

2.3.5 Sieve Analysis

****

NOTE: Delete reference to source of material when select material is not required and edit submittal requirements accordingly.

****

A minimum of one analysis shall be performed for each [1000] [_____] tons of material to be stabilized, with a minimum of 3 analyses for each day's run until the course is completed. When [the source of materials is changed] [and] [deficiencies] are found, the analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced at no additional cost to the Government.

2.3.6 Liquid Limit and Plasticity Index

One liquid limit and plasticity index shall be performed for each sieve analysis. Liquid limit and plasticity index shall be in accordance with ASTM D 4318.

2.3.7 Sampling and Testing During Construction

Quality control sampling and testing during construction shall be performed as required in paragraph FIELD QUALITY CONTROL.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Cement shall not be applied if the soil moisture content exceeds optimum moisture content specified for the cement-treated mixture. After mixing is completed, the proportions of the mixture shall be in accordance with the approved mix design. When application of water and mixing are completed, on the basis of dry weight, moisture shall not be below the optimum moisture content of the mixture nor shall it be more than 2 percent above the optimum moisture content. When the stabilized course is constructed in more than 1 layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire construction period to prevent water from collecting or standing on the areas to be stabilized or on pulverized, mixed, or partially mixed material. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be placed in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF BORROW PITS

****

NOTE: Paragraph will be deleted when select

material is not required or when small quantities do not justify the inclusion of select material.
****

[Borrow pits shall be cleared, stripped and excavated to working depth in a manner that produces excavation faces that are as nearly vertical as practicable for the materials being excavated. Strata of unsuitable materials overlying or occurring in the deposit shall be wasted. Methods of operating the pits and the processing and blending of the materials may be changed or modified if necessary to obtain material conforming to the specified requirements. Upon completion of the work, pits shall be conditioned to drain readily, and be left in a satisfactory condition.] [Borrow material shall be obtained from approved off-site sources.]

3.3 STOCKPILING MATERIALS

****
NOTE: Paragraph will be deleted when select material is not required or when small quantities do not justify the inclusion of select material.
****

Select material, including approved material available from excavation and grading shall be stockpiled in the manner and at the locations designated. Before stockpiling of material, the storage sites shall be cleared, drained, and leveled. Materials obtained from different sources shall be stockpiled separately.

3.4 PREPARATION OF AREA TO BE STABILIZED

****
NOTE: Inapplicable paragraph will be deleted.
****

Area to be stabilized shall be cleaned of debris, and shall be inspected for adequate compaction; and shall be capable of withstanding, without displacement, the compaction specified for the soil-cement mixture. Debris and removed unsatisfactory in-place material shall be disposed of as specified.

3.4.1 In-Place Material to be Stabilized

The entire area to be stabilized shall be graded and shaped to conform to the lines, grades, and cross sections shown in the plans, prior to being processed. Soft or yielding areas shall be made stable before construction is begun.

3.4.2 In-Place Materials to Receive Stabilized Course

****
NOTE: If this paragraph is retained, inapplicable portions will be deleted.
****

[Soft, yielding areas and ruts or other irregularities in the surface shall be corrected. Material in the affected areas shall be loosened and unsatisfactory material removed. Approved select material shall be added where directed. The area shall then be shaped to line, grade, and cross section, and shall be compacted to the specified density.] [Subgrade shall conform to Section 02300 EARTHWORK.] [Subbase course shall conform to Section 02721 SUBBASE COURSES.]

3.4.3 Select Material

****
NOTE: Delete if select material is not required.
****

Sufficient select material shall be utilized to provide the required thickness of the soil-cement layer after compaction and shall be processed to meet the requirements specified before cement stabilization is undertaken.

3.5 INSTALLATION

****
NOTE: For base courses for airfield pavements delete requirements for in-place materials, traveling plant, and in-place mix method. Specify a select material conforming to AASHTO M 147 or ASTM D 1241 and central plant mixing method.
****

3.5.1 Edges of Stabilized Course

Approved material shall be placed along the edges of the stabilized course in such quantity as will compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple-layer course, allowing at least a 1 foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the stabilized course.

3.5.2 Mixed-in-Place Method

3.5.2.1 Scarifying and Pulverizing of Soil

Prior to the application of cement, the soil shall be scarified and pulverized [to the depth shown] [to a depth of [_____] inches]. Scarification shall be carefully controlled so that the layer beneath the layer to be stabilized is not disturbed. Depth of pulverizing shall not exceed the depth of scarification. Unless otherwise permitted, the area scarified and pulverized shall not exceed the area that can be completed in 2 working days.

3.5.2.2 Application of Cement

Pulverized material shall be shaped approximately to the cross section indicated. Cement shall be applied so that when uniformly mixed with the soil, the specified cement content is obtained, and a sufficient quantity of cement-treated soil is produced to construct a compacted cement-treated course conforming to the lines, grades, and cross section indicated. Equipment, except that used in spreading and mixing operations, shall not pass over the freshly spread soil cement.

3.5.2.3 Dry Mixing

Immediately after the cement has been distributed, it shall be mixed with the soil. The cement shall not be mixed below the required depth. Mixing shall continue until the cement has been sufficiently blended with the soil to prevent the formation of cement balls when water is applied.

3.5.2.4 Water Application and Moist Mixing

Moisture content of the mixture shall be determined immediately after completion of mixing of the soil and cement. Water-supply and pressure distributing equipment shall be provided that will permit the continuous application within 3 hours of all water required on the section being processed. Water shall be incorporated in the mix so that concentration of water near the surface does not occur. After all the mixing water has been added, mixing shall be continued until the water is uniformly distributed throughout the full depth of the mixture, with no portion of the mixture remaining undisturbed during mixing for more than 30 minutes. Any portion of the mixture remaining undisturbed more than 30 minutes during mixing shall be disposed of as specified. Satisfactory moisture distribution shall occur along the edges of the section.

3.5.3 Central-Plant Method

The mixture shall be hauled to the job in trucks equipped with protective covers. Underlying course shall be thoroughly moistened and the material shall be deposited on the prepared area in a quantity that will produce a compacted base of uniform density to the required grade and cross section. Spreading or spreading-trimming equipment shall be constructed and operated to produce a layer of material which is uniform in thickness and surface contour and free from irregularities in density. Spreading or spreading-trimming equipment shall be used in sufficient numbers and operated in staggered formation to obtain full-width spreading in 1 construction operation. Not more than 60 minutes shall elapse between the start of the moist mixing and the start of compaction of the treated layer. Not more than 30 minutes shall elapse between the placement of the cement-treated soil in adjacent lanes on 2-lane structures at any location.

3.5.4 Traveling-Plant Method

Traveling plant shall move at a uniform rate of speed and shall accomplish thorough mixing of the materials. Water and cement shall be delivered from supply trucks or bins at a predetermined rate. Windrows of prepared soil-cement mixture shall be of sufficient size to cover a predetermined width to the indicated compacted thickness.

3.5.5 Layer Thickness

Compacted thickness of the stabilized course shall be [as indicated] [[_____] inches]. No layer shall be in excess of 8 inches nor less than 4 inches in compacted thickness.

3.5.6 Compaction

****
NOTE: Density will be based on the material being stabilized.
****

Before compaction operations are started and as a continuation of the mixing operation, the mixture shall be thoroughly loosened to the full depth. At the beginning of compaction, at least 80 percent of the soil shall pass a No. 4 sieve, and 100 percent shall pass the 1 inch sieve. Compaction shall be started immediately after mixing is completed. Density of compacted soil-cement mixture shall be at least [_____] percent of the maximum density obtained from the laboratory prepared samples. Loose mixture shall be uniformly and continuously compacted until the entire depth and width of the area are compacted to the density specified. The moisture content at the surface shall be maintained near optimum at all times through the rolling, but shall be less than that quantity which will cause the soil-cement mixture to become unstable during compaction. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Displacement of the mixture shall not occur due to the speed of the roller. Areas inaccessible to rollers shall be compacted with mechanical tampers.

3.6 FINISHING

The surface shall be moistened, if necessary, and shaped to the required lines, grades, and cross section. If necessary, the surface shall be lightly scarified to eliminate any imprints made by the compacting or shaping equipment. The surface shall then be thoroughly compacted to the specified density with rubber-tired rollers and smooth-wheel tandem rollers to the extent necessary to provide a smooth, dense, uniform surface that is free of surface checking, ridges, or loose material, and that conforms to the crown, grade, and line indicated. These finishing operations shall be completed within 2 hours after completion of mixing operations. In places not accessible to finishing and shaping equipment, the mixtures shall be compacted with mechanical tampers to the density specified and shall be shaped and finished by hand methods. Any portion of the compacted mix that has density less than that specified, that has not properly hardened, or that is improperly finished shall be corrected as specified below.

3.7 CONSTRUCTION JOINTS

At the end of each day's construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face free of loose or shattered material. Material along construction joints not properly compacted shall be removed and replaced with soil-cement that is mixed, moistened, and compacted as specified.

3.8 CURING AND PROTECTION

****

NOTE: It may be advantageous to specify only bituminous curing for stabilized base courses which are to receive bituminous surfacing under the contract, in which case, other curing materials and methods will be deleted.

****

The finished surface shall be protected against rapid drying for 7 days by one of the methods specified.

3.8.1 Moist Curing

A 2 inch covering of soil or not less than 4 pounds per square yard of straw shall be applied. The material shall be moistened initially and kept moistened throughout the curing period. In multiple-layer construction, the soil used in moist curing, if of approved select material, may be used for constructing the succeeding stabilized course.

3.8.2 Burlap

Burlap covers shall consist of 2 or more layers of burlap having a combined weight of 14 ounces or more per square yard in a dry condition. Burlap shall be either new or shall have been used only for curing concrete. Burlap strips shall have a length, after shrinkage, at least 1 foot greater than necessary to cover the entire width and edges of the finished stabilized area. Mats shall overlap each other at least 6 inches. Mats shall be thoroughly wetted before placing and shall be kept continuously wet and in contact with the surface and edges of the finished stabilized area for the entire curing period.

3.8.3 Impervious Sheeting

The surface of the finished stabilized area shall be moistened with a fine spray of water and then covered with impervious sheeting. The burlap of the polyethylene-coated burlap shall be thoroughly saturated with water before placing. Sheeting shall be placed with the light-colored side up. Sheets shall extend over the edges of the stabilized area and shall be held securely in place throughout the curing period. Edges of sheets shall overlap each other at least 12 inches and shall be securely cemented or taped to form continuous closed joints. Tears and holes in sheets shall be repaired immediately.

3.9 BITUMINOUS MATERIAL

****

NOTE: The last sentence will be deleted if sanding and dusting of the bituminous-cured surfaces is not required or if bituminous-cured surfaces are to receive bituminous surfacing under the contract.

The application temperatures will be selected from the following table and inserted in the blanks:

Liquid asphalt:	**Degree C**	**(Degrees F)**
RC-70 or MC-70	**50-85**	**(120-185)**
RC-250 or MC-250	**75-110**	**(165-230)**
Emulsified asphalt:		
RS-1	**25-55**	**(75-130)**
RS-2	**45-70**	**(110-160)**
Tar:		
RT-7	**65-105**	**(150-225)**
RT-8	**65-105**	**(150-225)**
RT-9	**65-105**	**(150-225)**
RT-10	**80-120**	**(175-250)**

****

Bituminous material shall be uniformly applied by means of a bituminous distributor within a temperature range of [_____] to [_____] degrees F, as directed. Bituminous material for curing shall be uniformly applied at the rate of 0.2 to 0.25 gallon per square yard. Areas inaccessible to or missed by the distributor shall be properly treated using the manually operated hose attachment. Bituminous material shall be applied only to the top layer. At the time the bituminous material is applied, the surface shall be free of loose or foreign matter and shall contain sufficient moisture to prevent excessive penetration of the bituminous material. When necessary, water in sufficient quantity to fill the surface voids shall be applied immediately before the bituminous material is applied. Treated surface shall be sanded or dusted to prevent the bituminous material from being picked up by traffic.

3.10 FIELD QUALITY CONTROL

3.10.1 Grade Control

Underlying material shall be excavated to sufficient depth for the required stabilized-course thickness. The finished stabilized course with the subsequent surface course shall meet the fixed grade. Finished and completed stabilized area shall conform to the lines, grades, cross section, and dimensions indicated.

3.10.2 Smoothness Test

****

NOTE: For subgrade and subbase stabilization, paragraph should be deleted.

****

The surface of a stabilized layer shall show no deviations in excess of 3/8 inch when tested with the straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing new material, or by reworking existing material and compacting, as directed. Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline with a straightedge. Measurements shall also be taken perpendicular to the road centerline at [50] [_____] foot intervals.

3.10.3 Thickness Control

****

NOTE: Thickness allowance may be modified to 6 mm (1/4 inch) when the course thickness is 150 mm (6 inches) or less. The designer may describe the sampling, testing, and approval considered necessary for a particular project.

****

The completed thickness of the stabilized course shall be within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, such areas shall be corrected by scarifying, adding mixture of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course shall be considered as conforming with the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 1/4 inch of the thickness indicated. The thickness of the stabilized course shall be measured at intervals which ensure one measurement for each [500] [_____] square yards of stabilized course. Measurements shall be made in 3 inch diameter test holes penetrating the stabilized course.

3.10.4 Testing

Field tests shall be performed in sufficient numbers to assure that the specifications are being met. Testing shall be the responsibility of the Contractor and shall be performed by an approved commercial laboratory.

3.10.5 Field Density

Field density tests shall be performed in accordance with ASTM D 1556or ASTM D 2922. ASTM D 2922 results in a wet unit weight of soil, and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. Calibration curves furnished along with the density gauge shall be checked as described in ASTM D 3017. Calibration checks of the density gauge shall be made at the beginning of a job on each type of material encountered. If ASTM D 2922 is used, in-place densities shall be checked by ASTM D 1556 at least once per lift for each [_____] square yard of stabilized material. Calibration curves and calibration test results shall be furnished within 24 hours of conclusion of the tests. At least 1 field density test shall be performed for each [250] [_____] square yards of each layer of base material.

3.10.6 Samples of Bituminous Materials

A sample of the bituminous material used shall be obtained by the Contractor under the supervision of the Contracting Officer. The sample will be retained by the Government.

3.10.7 Maintenance

The stabilized area shall be maintained in a satisfactory condition until the completed work is accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Defects shall be remedied as specified.

3.10.8 Traffic

Completed portions of the cement-treated soil area may be opened immediately to light traffic provided the curing is not impaired. After the curing period has elapsed, completed areas may be opened to all traffic provided that the cement-stabilized course has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic. Heavy equipment will not be permitted on the area during the curing period. Cement and water may be hauled over the area with pneumatic-tired equipment as approved. Finished portions of cement-stabilized soil that are traveled on by equipment used in constructing an adjoining section shall be protected in a manner that prevents equipment from marring or damaging the completed work.

3.11 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials that are unsuitable for stabilization, material that is removed for the required correction of defective areas, waste material, and debris shall be disposed of [as directed] [in disposal area indicated].

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02712 (December 1997)**
U.S. ARMY CORPS OF ENGINEERS **--------------------------**
Superseding
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GUIDE SPECIFICATION FOR CONSTRUCTION
Includes Text Adjustment Change (Section References) (November 1998)
Latest change indicated by CHG tags

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SECTION 02712

LIME-STABILIZED BASE COURSE, SUBBASE, OR SUBGRADE
12/97

****
NOTE: This guide specification covers the requirements for lime stabilization of subgrades, subbases, and base courses for airfield pavements and for roads, streets, and parking areas. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 81	(1992) Cut-Back Asphalt (Rapid-Curing Type)
AASHTO M 82	(1975) Cut-Back Asphalt (Medium-Curing Type)
AASHTO T 135	(1992) Wetting-and-Drying Test of Compacted Soil-Cement Mixtures
AASHTO T 136	(1992) Freezing-and-Thawing Tests of Compacted Soil-Cement Mixtures

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 25	(1996a) Chemical Analysis of Limestone, Quicklime, and Hydrated Lime
ASTM C 50	(1994) Sampling, Inspection, Packing, and Marking of Lime and Limestone Products
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 490	(1992) Road Tar
ASTM D 559	(1996) Wetting and Drying Compacted Soil-Cement Mixtures
ASTM D 560	(1996) Freezing and Thawing Compacted Soil-Cement Mixtures
ASTM D 633	(1987; R 1991) Volume Correction Table for Road Tar
ASTM D 977	(1991) Emulsified Asphalt
ASTM D 1250	(1980; R 1990) Petroleum Measurement Tables
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 1632	(1996) Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory
ASTM D 1633	(1996) Compressive Strength of Molded

	Soil-Cement Cylinders
ASTM D 2027	(1976; R 1992) Cutback Asphalt (Medium-Curing Type)
ASTM D 2028	(1976; R 1992) Cutback Asphalt (Rapid-Curing Type)
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place By Nuclear Methods (Shallow Depth)
ASTM D 4318	(1995a) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes

1.2 MEASUREMENT FOR PAYMENT

****

NOTE: This paragraph will be deleted when lump-sum payment is desired.

Method of measurement not applicable to the job conditions will be deleted. If bituminous material is to be paid for separately, select the desired method of measurement. Paragraph Select Material will be deleted and reference to select material in article Basis for Payment will be deleted when select material is not required from borrow areas.

****

1.2.1 Lime Stabilization

Measurement will be by the square yard of work completed and accepted.

1.2.2 Lime

Measurement will be by the number of 2000 pound tons of lime used in the completed and accepted work. No measurement will be made for wasted lime or lime used in work determined defective.

1.2.3 Bituminous Material

Bituminous material to be paid for will be measured in the number of [gallons of the material used in the accepted work, corrected to gallons at 60 degrees F in accordance with [ASTM D 633] [ASTM D 1250]. A coefficient of 0.00025 per degree F shall be used for asphalt emulsion.] [2000 pound tons of the material used in the accepted work.]

1.2.4 Select Material

Select material will be measured by the [cubic yard] [2000-pound ton] of material placed and used in the completed and accepted stabilization. No measurement will be made for select material that is wasted or used in work determined defective.

1.3   WAYBILLS AND DELIVERY TICKETS

****
NOTE: This paragraph will be deleted when lump-sum payment is desired.
****

Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed waybills and certified delivery tickets shall be furnished for all lime [and bituminous materials] [and select materials] used in the construction.

1.4   BASIS FOR PAYMENT

****
NOTE: This paragraph will be deleted when lump-sum payment is desired.

Method of measurement not applicable to the job conditions will be deleted. If bituminous material is to be paid for separately, select the desired method of measurement.
****

Lime stabilization, constructed and accepted, including lime, [bituminous material] [and select material] will be paid for at the respective contract unit prices in the bidding schedule. No payment will be made for any material wasted, used for the convenience of the Contractor, unused or rejected, or for water used. [Select material obtained from grading and excavation operations at the project site will not be paid for under this section but will be included for payment under other sections specifying grading and excavating.] [No separate payment will be made for sanding or dusting the bituminous prime-coated surfaces, and all costs for sanding or dusting shall be included in the contract unit price for bituminous material.]

1.5   DEFINITIONS

1.5.1   Lime-Stabilized Course

Lime-stabilized course, as used in this specification, is a mixture of lime and in-place or select borrow material uniformly blended, wetted, and thoroughly compacted to produce a pavement course which meets the criteria set forth in the plans and this specification.

1.5.2   Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557abbreviated as percent laboratory maximum density.

1.6   JOB DESCRIPTION

The work specified consists of the construction of a lime-stabilized [base] [subbase] [subgrade] course. The work shall be performed in accordance with this specification and shall conform to the lines, grades, notes, and typical sections shown in the drawings. Sources of materials shall be selected well in advance of the time when materials will be required in the work.

1.7 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Plant, Equipment, Machines, and Tools; [_____]. Mix Design; [_____].

List of proposed equipment to be used in performance of construction work including descriptive data. Mix design at least [_____] days before it is to be used.

SD-09 Reports

Sampling and Testing; [_____]. Field Density; [_____].

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within [24] [_____] hours after the tests are performed. Certified copies of test results of materials and sources not less than [30] [_____] days before material is required for the work.

SD-18 Records

Waybills and Delivery Tickets; [_____].

Copies of waybills and delivery tickets during the progress of the work. Certified waybills and delivery tickets for all materials actually used.

1.8 STOCKPILING MATERIALS

****

NOTE: This paragraph will be deleted when select material is not required or when small quantities do

not justify the inclusion of select material.
****

Select material, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Before stockpiling material, storage sites shall be cleared and sloped to drain. Materials obtained from different sources shall be stockpiled separately.

1.9 PLANT, EQUIPMENT, MACHINES, AND TOOLS

****
NOTE: Types of equipment specified but not required for this type of base course will be deleted, and other items of equipment not listed will be added as appropriate.
****

1.9.1 General Requisites

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in satisfactory working condition at all times. Other compacting equipment may be used in lieu of that specified, where it can be demonstrated that the results are equivalent. Protective equipment, apparel, and barriers shall be provided to protect the eyes, respiratory system, and the skin of workers exposed to contact with lime dust or slurry.

1.9.2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be the self-propelled type with a total weight of not less than 10 tons, and a minimum weight of 300 pounds per inch width of rear wheel. Wheels of the rollers shall be equipped with adjustable scrapers. The use of vibratory rollers is optional.

1.9.3 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall have 4 or more tires, each loaded to a minimum of 30,000 pounds and inflated to a minimum pressure of 150 psi. The loading shall be equally distributed to all wheels, and the tires shall be uniformly inflated. Towing equipment shall also be pneumatic-tired.

1.9.4 Mechanical Spreader

Mechanical spreader shall be self-propelled or attached to a propelling unit capable of moving the spreader and material truck. The device shall be steerable and shall have variable speeds forward and reverse. The spreader and propelling unit shall be carried on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material. The spreader shall contain a hopper, an adjustable screed, and outboard bumper rolls; and shall be designed to have a uniform, steady flow of material from the hopper. The spreader shall be capable of laying material without segregation across the full width of the lane to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers shall conform to thickness and grade requirements indicated. The Contracting Officer may require a demonstration of the spreader prior to approving use in performance of the work.

1.9.5 Sprinkling Equipment

Sprinkling equipment shall consist of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

1.9.6 Tampers

Tampers shall be of an approved mechanical type, operated by either pneumatic pressure or internal combustion, and shall have sufficient weight and striking power to produce the compaction required.

1.9.7 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one [10] [12] footstraightedge for each bituminous paver, for use in the testing of the finished surface. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

1.10 WEATHER LIMITATIONS

Work on the base course shall not be performed during freezing temperatures. When the temperature is below 40 degrees F, the completed base course shall be protected against freezing by a sufficient covering of straw, or by other approved methods, until the course has dried out. Any areas of completed base course that are damaged by freezing, rainfall, or other weather conditions shall be brought to a satisfactory condition without additional cost to the Government. Lime shall not be applied when the atmospheric temperature is less than 40 degrees F. No lime shall be applied to soils that are frozen or contain frost, or when the underlying material is frozen. If the temperature falls below 35 degrees F, completed lime-treated areas shall be protected against any detrimental effects of freezing.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Lime

Lime shall be a standard brand of [quicklime] [hydrated lime] conforming to the following physical and chemical requirements:

a. Lime shall be of such gradation that 99-1/2 percent passes a No. 20 sieve and a minimum of 85 percent passes a No. 100 sieve.

b. Combined calcium oxide and magnesium oxide shall be not less than [92 percent] [70 percent].

2.1.2 Bituminous Material

****

NOTE: Tar or asphalt of one grade or type will be specified.

****

Material shall conform to one of the following:

2.1.2.1 Cutback Asphalt

[AASHTO M 81] [AASHTO M 82] [ASTM D 2027] [ASTM D 2028], Grade [RC-250] [RC-800] [MC-250] [MC-800].

2.1.2.2 Emulsified Asphalt

ASTM D 977, Type [RS-1] [RS-2].

2.1.2.3 Tar

ASTM D 490, Grade [RT-7] [RT-8] [RT-9] [RT-10].

2.1.3 Material to be Stabilized

****

NOTE: Soils classified as CH, CL, MH, SC, and GC have potential for lime stabilization; however, it is not recommended to use lime alone for the stabilization of sandy soils. Designer should refer to TM 5-822-14 and TM 5-825-2 for further guidance.

****

Material to be stabilized shall consist of [in-place material in the area] [approved select material. Select material shall be free of deleterious substances such as sticks, debris, organic matter, and stones greater than 3 inches in any dimension. At least 10 percent of the material shall pass the No. 40 sieve. Plasticity index shall be greater than 12].

2.1.4 Water

Water shall be clean, fresh, and free from injurious amounts of oil, acid, salt, alkali, organic matter, and other substances deleterious to the lime or soil-lime mixture, and shall be subject to approval.

2.2 MIX DESIGN

****

NOTE: The designer should determine the compressive strength requirement based on the use of the final pavement. Generally, a compressive strength of 1.035 MPa (150 psi) is minimum. Designer should refer to TM's 5-822-14 and 5-825-2 for further guidance, including applicability of stabilization with lime.

****

The Contractor shall develop and submit for approval a proposed mix design prior to stabilization work. Mix shall be developed using samples of the material to be stabilized. Mix design shall be capable of producing a compressive strength of [_____] [150] psi when compacted to the design percent of laboratory maximum density. Samples shall not show any significant loss of strength after 12 cycles of the durability test.

PART 3 EXECUTION

3.1 LIME STABILIZATION MIXTURE

The material to be stabilized shall be thoroughly pulverized and, when lime is applied in the dry state, the mix shall be thoroughly blended at a moisture content below optimum. After mixing is completed, the proportions of the mixture shall be in accordance with the approved mix design. After blending, water shall be blended into the dry mix in amounts necessary to bring the moisture content to optimum. Field moisture content shall be controlled within plus or minus [2] [_____] percent of optimum. When the stabilized course is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweeper or power brooms except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire construction period to prevent water from collecting or standing on the area to be stabilized or on pulverized, mixed, or partially mixed material. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF BORROW PITS

****

NOTE: This paragraph will be deleted when select material is not required or when small quantities do not justify the inclusion of select material.

****

[Borrow pits shall be cleared, stripped and excavated in a manner that exposes vertical faces of the deposit for suitable working depths. Strata of unsuitable materials overlying or occurring in the deposit shall be wasted. Methods of operating pits and the processing and blending of materials may be changed or modified if necessary to obtain material conforming to the specified requirements. Upon completion of the work, pits shall be conditioned to drain readily, and be left in a satisfactory condition.] [Borrow material shall be obtained from off site sources.]

3.3 PREPARATION OF AREA TO BE STABILIZED

The area shall be cleaned of debris. The area will be inspected for adequate compaction and shall be capable of withstanding, without displacement, the compaction specified for the soil-lime mixture. Debris and removed unsatisfactory in-place material shall be disposed of as specified.

3.3.1 In-Place Material to be Stabilized

The entire area shall be graded to conform to the lines, grades, and cross sections shown in the plans prior to being processed. Soft or yielding subgrade areas shall be made stable before construction is begun.

3.3.2 In-Place Material to Receive Stabilized Course

[Soft, yielding areas and ruts or other irregularities in the surface shall be corrected. The material in the affected areas shall be loosened and unsatisfactory material removed. Approved select material shall be added where directed. The area shall then be shaped to line, grade, and cross section, and shall be compacted to the specified density.] [Subgrade shall conform to Section 02300 EARTHWORK FOR ROADWAYS, RAILROADS, AND

AIRFIELDS.] [Subbase course shall conform to Section 02721 SUBBASE COURSES.]

3.3.3 Quantity of Select Material

****

NOTE: Select material will be described by physical properties, soil types, and location, as required. See TM 5-822-14 and TM 5-825-2 for further guidance. The subparagraph will be deleted if select material is not required.

****

Sufficient select material shall be utilized to provide the required thickness of the soil-lime layer after compaction. [Where in-place mixing is to be accomplished, the soil shall be graded and shaped to the approximate section and grade shown before lime stabilization is undertaken.]

3.3.4 Grade Control

Underlying material shall be excavated to sufficient depth for the required stabilized-course thickness so that the finished stabilized course with the subsequent surface course will meet the fixed grade. Finished and completed stabilized area shall conform to the lines, grades, cross section, and dimensions indicated.

3.4 INSTALLATION

3.4.1 Mixed In-Place Method

3.4.1.1 Scarifying and Pulverizing of Soil

Prior to application of lime, the soil shall be scarified and pulverized [to the depth shown] [to a depth of [_____] inches.] Scarification shall be controlled so that the layer beneath the layer to be treated is not disturbed. Depth of pulverizing shall not exceed the depth of scarification.

3.4.1.2 Application of Lime

Pulverized material shall be shaped to approximately the cross section indicated. Lime shall be applied so that when uniformly mixed with the soil, the specified lime content is obtained, and a sufficient quantity of lime-treated soil is produced to construct a compacted lime-treated course conforming to the lines, grades, and cross section indicated. Mechanical spreaders shall be used in applying bulk lime. Distributors shall be used in applying slurry. If lime is spread by hand, the bags shall be spotted accurately on the area being stabilized so that when the bags are opened the lime will be dumped and spread uniformly on the area being processed. No equipment except that used in spreading and mixing shall pass over the freshly applied lime.

3.4.1.3 Initial Mixing

Immediately after the lime has been distributed, the lime and soil shall be mixed. Initial mixing shall be sufficient to alleviate any dusting or wetting of the lime that might occur in the event of wind or rainstorms. This may be accomplished several days in advance of the final application and mixing.

3.4.1.4   Water Application and Moist Mixing

Moisture content of the mixture shall be determined in preparation for final mixing. Moisture in the mixture following final mixing shall not be less than the water content determined to be optimum based on dry weight of soil and shall not exceed the optimum water content by more than [2] [_____] percentage points. Water may be added in increments as large as the equipment will permit; however, such increment of water shall be partially incorporated in the mix to avoid concentration of water near the surface. After the last increment of water has been added, mixing shall be continued until the water is uniformly distributed throughout the full depth of the mixture, including satisfactory moisture distribution along the edges of the section.

3.4.2   Edges of Stabilized Course

Approved material shall be placed along the edges of the stabilized course in a quantity that will compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple-layer course, allowing at least a 1 foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the stabilized course.

3.4.3   Central-Plant Method

****

NOTE: Central plant will be specified for mixing select material for subbase or base course construction.

****

Plant shall be capable of producing a uniform lime-treated mixture at the specified lime and moisture contents. Mixture shall be hauled to the job in trucks equipped with protective covers. Underlying course shall be thoroughly moistened and the mixture then placed on the prepared area in a uniform layer with mechanical spreaders. The layer shall be uniform in thickness and surface contour; and the completed layer, after compaction, shall conform to the required grade and cross section.

3.4.4   Traveling-Plant Method

****

NOTE: Traveling plant will be specified for mixing in-place material for subbase and base course construction.

****

Traveling plant shall move at a uniform rate of speed and shall accomplish thorough mixing of the materials in one pass. Water and lime shall be delivered from supply trucks or bins at a predetermined rate. Windrows of prepared soil-lime mixture shall cover a predetermined width to the indicated compacted thickness.

3.4.5   Layer Thickness

Compacted thickness of the stabilized course shall be [as indicated]

[_____ inches.] No layer shall be more than 8 inches or less than 3 inches in compacted thickness.

3.4.6 Compaction

****

NOTE: Density will be based on the material being stabilized.

****

Before compaction operations are started and as a continuation of the mixing operation, the mixture shall be thoroughly loosened and pulverized to the full depth. Compaction shall be started immediately after mixing is completed. During final compaction, the surface shall be moistened, if necessary, and shaped to the required lines, grades, and cross section. Density of compacted mixture shall be at least [90] [_____] percent of laboratory maximum density. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. At all times, the speed of the roller shall not cause displacement of the mixture to occur. Areas inaccessible to the rollers shall be compacted with mechanical tampers, and shall be shaped and finished by hand methods.

3.4.7 Finishing

The surface of the top layer shall be finished to the grade and cross section shown. The surface shall be of uniform texture. Light blading during rolling may be necessary for the finished surface to conform to the lines, grades, and cross sections. If the surface for any reason becomes rough, corrugated, uneven in texture, or traffic-marked prior to completion, the unsatisfactory portions shall be scarified, reworked, relaid, or replaced as directed. If any portion of the course, when laid, becomes watersoaked for any reason, that portion shall be removed immediately, and the mix placed in a windrow and aerated until a moisture content within the limits specified is obtained; and then spread, shaped, and rolled as specified above.

3.4.8 Construction Joints

At the end of each phase of construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face free of loose or shattered material. Material along construction joints not properly compacted shall be removed and replaced with soil-lime mixture that is mixed, moistened, and compacted as specified.

3.4.9 Curing and Protection

****

NOTE: It may be advantageous to specify only bituminous curing for pavements that are to receive bituminous surfacing under the contract, in which case moist curing will be deleted, and the first sentence in the paragraph will be modified accordingly. This specification section must be coordinated with other sections covering the various components of the pavement structure.

****

Immediately after the soil-lime area has been finished as specified above, the surface shall be protected against rapid drying for 7 days [by one of the methods specified below] [_____].

3.4.9.1   Moist Curing

The area shall be moistened by sprinkling and shall be kept moist for the 7-day curing period.

3.4.9.2   Bituminous Material

****

NOTE: The application temperatures will be selected from the following table and inserted in the blanks:

	Degrees F
Cutback asphalt:	
RC-250, MC-250	**145-220**
RC-800, MC-800	**180-255**
Emulsified asphalt:	
RS-1	**75-130**
RS-2	**110-160**
Tar:	
RT-7	**150-225**
RT-8	**150-225**
RT-9	**150-225**
RT-10	**175-250**

****

Bituminous material shall be uniformly applied by means of a bituminous distributor within a temperature range of [_____] to [_____] degrees F. Bituminous material shall be applied in quantities of not less than 0.1 gallon per square yard nor more than 0.25 gallon per square yard. Areas inaccessible to or missed by the distributor shall be properly treated using the manually operated hose attachment. Bituminous material shall be applied only to the top layer. At the time the bituminous material is applied, the surface of the area shall be free of loose or foreign matter and shall contain sufficient moisture to prevent excessive penetration of the bituminous material. When necessary, the area shall be sprinkled immediately before the bituminous material is applied. Treated surface shall be [sanded] [dusted] [_____] to prevent the bituminous material from being picked up by traffic.

3.5   SAMPLING AND TESTING

3.5.1   General Requirements

****

NOTE: Delete reference to source of material if select material is not required.
****

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. Work requiring testing will not be permitted until the facilities have been inspected and approved. The first inspection will be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Tests shall be performed in sufficient numbers and at the locations and times directed to ensure that materials and compaction meet specified requirements. Certified copies of the test results shall be furnished to the Contracting Officer.

3.5.2 Results

Results shall verify that the material complies with the specification. When [the source of materials is changed] [deficiencies are found], the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced.

3.5.3 Sampling

All aggregate samples for laboratory testing shall be taken in accordance with ASTM D 75. Samples of lime shall be taken in accordance with ASTM C 50. Specimens for the unconfined compression tests shall be prepared in accordance with ASTM D 1632.

3.5.4 Sieve Analysis

Before starting work, one sample of material to be stabilized shall be tested in accordance with ASTM C 136 and ASTM D 422 on sieves conforming to ASTM E 11. After the initial test, a minimum of one analysis shall be performed for each [1000] [_____] tons of material placed, with a minimum of three analyses for each day's run until the course is completed.

3.5.5 Liquid Limit and Plasticity Index

One liquid limit and plasticity index shall be performed for each sieve analysis. Liquid limit and plasticity index shall be in accordance with ASTM D 4318.

3.5.6 Chemical Analysis

Lime shall be tested for the specified chemical requirements in accordance with ASTM C 25. Three tests shall be conducted for each delivery of lime.

3.5.7 Testing

Unconfined compression tests shall be conducted in accordance with ASTM D 1633. Three tests shall be conducted for each mix design tested. Samples shall be cured at a constant moisture content and temperature for 28 days. [Wet-dry tests shall be conducted in accordance with [AASHTO T 135] [ASTM D 559].] [Freeze-thaw tests shall be conducted in accordance with [AASHTO T 136] [ASTM D 560].] Three tests shall be conducted for each mix design tested. Scratch portion of the test shall be omitted.

3.6 FIELD QUALITY CONTROL

Tests shall provide a moisture-density relationship for the lime-soil mixture. Results of field quality control testing shall verify that materials comply with this specification. [When a material source is changed, [the new material shall be tested for compliance] [_____]]. When deficiencies are found, the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or repaired, as directed by the Contracting Officer, at no additional cost to the Government.

3.6.1 Thickness Control

****

NOTE: When subbase or base courses are constructed less than 150 mm (6 inches) in total thickness, a deficiency of 13 mm (1/2 inch) in thickness is considered excessive. Applicable to job conditions, thickness tolerance provisions may be modified as required, restricting all deficiencies to not over 6 mm (1/4 inch).

****

Completed thicknesses of the stabilized course shall be within 1/2 inch of the thickness indicated. Where the measured thickness of the stabilized course is more than 1/2 inch deficient, such areas shall be corrected by scarifying, adding mixture of proper gradation, reblading, and recompacting as directed. Where the measured thickness of the stabilized course is more than (1/2 inch thicker than indicated, it shall be considered as conforming to the specified thickness requirement. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 1/4 inch of the thickness indicated. Thickness of the stabilized course shall be measured at intervals which ensure one measurement for each [500] [_____] square yards of stabilized course. Measurements shall be made in 3 inch diameter test holes penetrating the stabilized course.

3.6.2 Field Density

Field in-place density shall be determined in accordance with [ASTM D 1556] [ASTM D 2167] [ASTM D 2922]. [When ASTM D 2922 is used, the calibration curves shall be checked, and adjusted if necessary, using the sand cone method as described in paragraph Calibration of the ASTM publication.] ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017. If ASTM D 2922 is used, in-place densities shall be checked by ASTM D 1556 at least once per lift for each [_____] square yard of stabilized material. Calibration curves and calibration tests results shall be furnished to the Contracting Officer within 24 hours of conclusion of the tests. At least one field density test shall be performed for each [250] [_____] square yards of each layer of base material.

3.6.3 Smoothness Test

****

NOTE: For subgrade and subbase stabilization, this paragraph should be deleted.
****

The surface of a stabilized layer shall show no deviations in excess of 3/8 inch when tested with the [10-] [12-] foot straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed. Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline with a [10-] [12-] foot straightedge. Measurements shall also be taken perpendicular to the road centerline at [50-] [_____] foot intervals.

3.7 TRAFFIC

Completed portions of the lime-treated soil area may be opened immediately to light traffic provided the curing is not impaired. After the curing period has elapsed, completed areas may be opened to all traffic, provided the stabilized course has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic. Heavy equipment shall not be permitted on the area during the curing period. Lime and water may be hauled over the completed area with pneumatic-tired equipment if approved. Finished portions of lime-stabilized soil that are traveled on by equipment used in constructing an adjoining section shall be protected in a manner to prevent equipment from marring or damaging completed work.

3.8 MAINTENANCE

Stabilized area shall be maintained in a satisfactory condition until the completed work is accepted. Maintenance shall include immediate repairs of any defects and shall be repeated as often as necessary to keep the area intact. Defects shall be corrected as specified herein.

3.9 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials that are unsuitable for stabilization, material that is removed for the required correction of defective areas, waste material, and debris shall be disposed of [as directed] [in waste disposal areas indicated].

-- End of Section --

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DEPARTMENT OF THE ARMY **HED-02721 (February 2000)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**
Superseding
HED-02721 (April 1999)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes Text Adjustment Change (Section References) (November 1998
Latest change indicated by CHG tags

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02/00

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SECTION 02721

SUBBASE COURSES
02/00

****
NOTE: This guide specification covers the requirements for subbase and select-material subbase courses for airfield pavements, roads and streets where subbases are used. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-700.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: This guide specification is applicable to subbase courses for airfield pavements, roads and streets including select-material subbase courses in the lower levels of the pavement structure. This specification will be used for any subbase course that has a design California bearing ratio (CBR) between 20 and 50 or any select-material with design CBR less than 20. Select material subbase will not require processing or blending.

This specification may also be used for:

a. The base course directly beneath the bituminous surface of a pavement design for Class E and F roads and streets where the predetermined CBR value of the material is 50 or more and the material conforms to Gradation No. 1.

b. The base course beneath rigid pavements.

When this guide specification is used for base course, section title of the project specification will be: RIGID BASE COURSE and the word "subbase" will be changed to "rigid base" throughout. When this guide specification is used in combination for a subbase course in some areas and a base course in other areas, the section title will be: SUBBASE AND RIGID BASE COURSE and the words "or rigid base" will be inserted after "subbase" throughout.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(1993) Moisture-Density Relations of Soils Using a 10-1b. (4.54 kg) Rammer and a 18-inch (457 mm) Drop

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 29	(1991a) Unit Weight and Voids in Aggregate
ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1995a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of

	Soils
ASTM D 1556	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 1883	(1994) CBR (California Bearing Ratio) of Laboratory Compacted Soils
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 4318	(1993) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4253	(1993) Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes

1.2 DEGREE OF COMPACTION

****

NOTE: ASTM D 1557 will be used for maximum density determinations if the anticipated material gradation should contain less than 30% retained on the 19 mm (3/4 inch) sieve. AASHTO T 180, Method D will be used for the maximum density determinations if the anticipated material gradation should contain more than 30% retained on the 19 mm (3/4 inch) sieve.

****

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557-91, Method C, for material that has <u>no more</u> than 30 percent retained on the 3/4 inch sieve and has <u>more</u> than 20 percent retained on the 3/8 inch sieve. Where the material <u>does</u> not meet these gradation requirements, AASHTO T 180 Method D will be used. Where free draining soils, i.e., sand or gap-graded aggregate are to be compacted, use ASTM D 4253. The procedure will be abbreviated below as a percentage of laboratory density.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary

for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment; FIO.

List of proposed equipment to be used in performance of construction work, including descriptive data.

SD-09 Reports

Sampling and Testing; GA.
Copies of initial and in-place test results.

1.4 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved testing laboratory in accordance with Section 01451 CONTRACTOR QUALITY CONTROL. Tests shall be performed at the specified frequency. No work requiring testing will be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements.

1.4.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.4.2 Tests

1.4.2.1 Sieve Analysis

Sieve analysis shall be made in conformance with ASTM C 117 and ASTM C 136 and ASTM D 422. Sieves shall conform to ASTM E 11.

1.4.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.

1.4.2.3 Moisture-Density Determinations

****

NOTE: ASTM D 1557 will be used for maximum density determinations if the anticipated material gradation would contain less than 30% retained on the 19 mm (3/4 inch) sieve. AASHTO T 180, Method D will be used for the maximum density determinations if the anticipated material gradation would contain more than 30% retained on the 19 mm (3/4 inch) sieve.

****

The maximum density and optimum moisture shall be determined in accordance with ASTM D 1557 or AASHTO T 180, Method D as determined in paragraph, Degree of Compaction.

1.4.2.4 Density Tests

Density shall be field measured in accordance with ASTM D 1556. The base plate, as shown in the drawing shall be used. If ASTM D 2922 is used, the calibration curves shall be checked and adjusted, if necessary, using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D 2922 result in a wet unit weight of soil and, when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration, in ASTM D 2922, on each different type of material to be tested at the beginning of a job and at intervals as directed.

1.4.2.5 Wear Test

****

NOTE: This paragraph will be retained only when subbase course materials (CBR between 20 and 50) are specified.

****

Wear tests shall be made on subbase course material in conformance with ASTM C 131.

1.4.2.6 CBR Test

Three sieve analysis and three California Bearing Ratio (CBR) tests shall be performed for each recycled asphaltic concrete or base course material the contractor proposes to use as subbase course. The CBR samples shall be compacted to 100% of maximum density at optimum moisture content. All three CBR strengths must be greater than 30.

1.4.3 Testing Frequency

1.4.3.1 Initial Tests

One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements prior to installation.

a. Sieve Analysis not including 0.02 mm size material

b. Liquid limit and plasticity index
c. Wear
d. Moisture-density relationship.
e. CBR.

1.4.3.2 In-Place Tests

****
NOTE: Field density tests and laboratory tests are generally performed at a frequency of one set of tests for every 1000 square meters (yards) of completed area. Other frequency intervals may be specified when conditions warrant. It is important that both field density tests and laboratory tests be conducted on the same materials.

The designer should determine the frequency of wear tests based on hardness of aggregates in the local area. In some areas only initial wear tests may be needed.
****

One of each of the following tests shall be performed on samples taken from the placed and compacted subbase course. Samples shall be taken for each 1000 square yards of each layer of material placed in each area.

Field Density and moisture content

1.4.4 Approval of Material

The source of the material shall be selected 30 days prior to the time the material will be required in the work. Approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and compacted subbase course.

1.5 EQUIPMENT

****
NOTE: If desirable, requirements for types of equipment applicable to methods of construction based on local conditions will be included.
****

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Subbase Course

****

NOTE: As written, this paragraph applies to general conditions. Other materials such as disintegrated granite, volcanic ash or cinders, limerock, and caliche will be specified when supported by adequate performance data. The requirement for percentage of wear will be deleted when local experience indicates the material is satisfactory. The material requirements from State or other local highway agency specifications may be incorporated in contract documents for constructing subbase course for roads, streets, or similar-use pavements if conditions a, b, c, and d below are met:

a. The percentage of material by weight passing the 0.075 mm (No. 200) sieve will not exceed 15.

b. When local conditions dictate a nonfrost-susceptible material, particles having a diameter of less than 0.02 mm will not be in excess of 3 percent.

c. The portion of the material passing the 0.425 mm (No. 40) sieve will have a liquid limit not greater than 25 and a plasticity index not greater than 5.

d. The project requires less than 600 cubic meters (750 cubic yards) of material and it is not an airfield pavement. (See item e below if project does not meet this requirement).

e. Approval from the USACE, TSMCX is required before state or other local highway specifications may be used for road or street projects requiring over 600 cubic meters (750 cubic yards) and/or airfield projects. Project specific information will be submitted to the TSMCX with the request for approval.

The desired maximum top size will be inserted in the blank. The necessity for meeting grades dictates that maximum top size should not exceed 75 mm (3 inches). Gradation No. 1 will be used where the design CBR is 41 to 50, No. 2 will be used where the design CBR is 31 to 40, and No. 3 will be used where the design CBR is 30 or less. Gradation band No. 1 or 2 may be used for lower design CBR values than specified above where no increase in price results. Gradation No. 1 will be used when a drainage layer will be placed above the subbase and the subbase is designed as a separation layer. Exceptions to the gradation requirements will be permitted by USACE, when supported by adequate in-place CBR data. When this specification is to be used as base course for roads, streets, and parking areas, the maximum top

size will not exceed 50 mm (2 inches) for a layer thickness of less than 150 mm (6 inches). The inapplicable gradation will be deleted.

Where local conditions dictate a nonfrost-susceptible material, retain the sentence in brackets requiring particles having a diameter of less than 0.02 mm not to exceed 3 percent by weight of the total aggregate, as determined in accordance with ASTM D 422.

When this specification is used for base course under rigid pavements, gradation band No. 4 will be used. The gradation will also meet the requirements in the applicable technical manual or engineering instruction for pavement design for frost conditions.
****

Aggregates shall consist of crushed stone or slag, gravel, shell, sand, or other sound, durable, approved materials processed and blended or naturally combined. Aggregates shall be durable and sound, free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material. Material retained on the No. 4 sieve shall have a percentage of wear not to exceed 50 percent after 500 revolutions when tested as specified in ASTM C 131. Aggregate shall be reasonably uniform in density and quality. Aggregates shall have a maximum size of 2-1/2 inches and shall be within the limits specified as follows:

Maximum Allowable Percentage by Weight
Passing Square-Mesh Sieve

Sieve Designation	No. 1
No. 10	50
No. 200	15

The portion of any blended component and of the completed course passing the No. 40 sieve shall be either nonplastic or shall have a liquid limit not greater than 25 and a plasticity index not greater than 5.

2.1.2 Select-Material Subbase Course

****
NOTE: When used as material for embankment, the applicable specification will be used to determine the maximum size of particles. The requirement on the amount passing the 0.075 mm (No. 200) sieve may be increased for locally available materials but will not be relaxed to the point where materials with insufficient CBR under ASTM D 4429 will pass.

Where local conditions dictate a nonfrost-susceptible material, retain the sentence in brackets requiring particles having a diameter of less than 0.02 mm not exceed 3 percent by weight of

the total aggregate, as determined in accordance with ASTM D 422.

****

Materials shall consist of selected soil or other materials from field excavation, stockpiles, or other sources. Material shall be free from lumps and balls of clay and from organic and other objectionable matter. Not more than 25 percent by weight shall pass the No. 200 sieve. The portion of material passing the No. 40 sieve shall have a liquid limit less than 35 and a plasticity index less than 12. The maximum particle size shall not exceed 3 inches.

2.1.3 Recycled Asphaltic Concrete and Base Course

Milled and screened asphaltic concrete or base course material from existing pavements may be used as subbase course material provided it meets the gradation requirements for subbase course and have a CBR strength greater than 30. Outside sources of asphaltic concrete or base course will not be permitted.

PART 3 EXECUTION

3.1 OPERATION OF AGGREGATE SOURCES

All clearing, stripping and excavating work involved in the opening or operation of aggregate sources shall be performed by the Contractor. Aggregate sources shall be opened to working depth in a manner that produces excavation faces that are as nearly vertical as practicable for the materials being excavated. Materials excavated from aggregate sources shall be obtained in successive cuts extending through all exposed strata. All pockets or strata of unsuitable materials overlying or occurring in the deposit shall be wasted as directed. The methods of operating aggregate sources and the processing and blending of the material may be changed or modified by the Contracting Officer, when necessary, in order to obtain material conforming to specified requirements. Upon completion of work, aggregate sources on Government reservations shall be conditioned to drain readily, and shall be left in a satisfactory condition. Aggregate sources on private lands shall be conditioned in agreement with local laws and authorities.

3.2 STOCKPILING MATERIAL

****

NOTE: In cases where material was previously stockpiled for the item of work, the following paragraph should be deleted and a separate item of work be developed to provide for the use of the stockpiled materials.

****

Prior to stockpiling of material, storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas designated by the Contracting Officer so as to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

3.3   PREPARATION OF UNDERLYING MATERIAL

****

NOTE: Stabilization of cohesionless materials may be obtained by other methods based on local experience; these methods (e.g., cement, lime, bitumen, chemicals), as well as any stabilization of cohesive materials, will be subject to approval by CEMP-ET. When used, edit this bracketed sentences accordingly.

****

Prior to constructing the subbase course, the underlying course or subgrade shall be cleaned of all foreign substances. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. Ruts, or soft yielding spots, in the underlying courses, subgrade areas having inadequate compaction, and deviations of the surface from the specified requirements, shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D 2487, the surface shall be stabilized prior to placement of the subbase course. Stabilization shall be accomplished by mixing subbase-course material into the underlying course, and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements for the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the subbase course is placed.

3.4   GRADE CONTROL

The finished and completed subbase course shall conform to the lines, grades, and cross sections shown. The lines, grades, and cross sections shown shall be maintained by means of line and grade stakes placed by the Contractor at the work site.

3.5   MIXING AND PLACING MATERIALS

****

NOTE: More details on applicable method for placing, mixing, and spreading should be included when appropriate.

****

The materials shall be mixed and placed to obtain uniformity of the subbase material at the water content specified. The Contractor shall make such adjustments in mixing or placing procedures or in equipment as may be directed to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to insure a satisfactory subbase course.

3.6   LAYER THICKNESS

The compacted thickness of the completed course shall be as indicated. When a compacted layer of 6 inches is specified, the material may be placed in a single layer; when a compacted thickness of more than 6 inches is required, no layer shall exceed 6 inches nor be less than 3 inches when compacted.

3.7 COMPACTION

Each layer of the subbase course shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within plus or minus 3 percent of optimum water content, as determined from laboratory tests, as specified in paragraph SAMPLING AND TESTING. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Compaction shall continue until each layer is compacted through the full depth to at least 100 percent of laboratory maximum density. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory subbase course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

3.8 EDGES

Approved material shall be placed along the edges of the subbase course in such quantity as will compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, at least a 1 foot width of the shoulder shall be rolled and compacted simultaneously with the rolling and compacting of each layer of the subbase course, as directed.

3.9 SMOOTHNESS TEST

The surface of each layer shall not show deviations in excess of 3/8 inch when tested with a 12 footstraightedge applied parallel with and at right angles to the centerline of the area to be paved. Deviations exceeding this amount shall be corrected by removing material, replacing with new material, or reworking existing material and compacting, as directed.

3.10 THICKNESS CONTROL

****

NOTE: When subbase courses are constructed less than 150 mm (6 inches) in total thickness, a deficiency of 13 mm (1/2 inch) in the thickness of any area of such paving is considered excessive. Applicable to job conditions, the thickness tolerance provisions will therefore be modified as required, restricting all deficiencies to less than 6 mm (1/4 inch).

****

The completed thickness of the subbase course shall be in accordance with the thickness and grade indicated on the drawings. The thickness of each course shall be measured at intervals providing at least one measurement for each 500 square yards or part thereof of subbase course. The thickness measurement shall be made by test holes, at least 3 inches in diameter through the course. The completed subbase course shall not be more than 1/2 inch deficient in thickness nor more than 1/2 inch above or below the established grade. Where any of these tolerances are exceeded, the Contractor shall correct such areas by scarifying, adding new material of proper gradation or removing material, and compacting, as directed. Where the measured thickness is 1/2 inch or more thicker than shown, the course will be considered as conforming with the specified thickness requirements plus 1/2 inch. The average job thickness shall be the average of the job measurements as specified above but within 1/4 inch of the thickness shown.

3.11 MAINTENANCE

The subbase course shall be maintained in a satisfactory condition until accepted.

-- End of Section --

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GUIDE SPECIFICATION FOR CONSTRUCTION

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02722

AGGREGATE AND/OR GRADED-CRUSHED AGGREGATE BASE COURSE
02/00

****
NOTE: This guide specification covers the requirements for base course to be used directly under bituminous pavement courses. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-700.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: This guide specification is applicable to base courses placed directly beneath bituminous surface courses. The following must be taken into consideration when editing this specification.

a. The material in this specification and on the drawings should be referred to as "aggregate base course (ABC)" when it is used for bituminous: roads, streets, parking areas, airfield pavements designed for light loads, Type B and C traffic areas for medium load airfield pavements, airfield overruns, airfield Type D traffic areas, or airfield bituminous shoulders. "Aggregate Base Course" should be retained in the title and the rest of the

specification should be edited accordingly to retain the information necessary for this material. These material requirements should produce a base course with a California Bearing Ratio (CBR) of 80 or more.

b. The material in this specification and on the drawings should be referred to as "graded-crushed aggregate base course (GCA)" when it is used for: bituminous airfield pavements (other than those listed above); for other heavy duty bituminous pavements; wherever a base material with a CBR of 100 is required. "Graded-Crushed Aggregate Base Course" should be retained in the title and the rest of the specification should be edited accordingly to retain the information necessary for this material.

c. When this specification is to be used in projects that require both types of materials, the title of this specification should be "Aggregate and/or Graded-Crushed Aggregate Base Course". Care must then be taken to assure that the drawings clearly call out which material is being used in any particular place and that this specification is edited to retain the information for both types of materials. If only a small amount of one of these types of materials is needed for the project, consideration should be made to determine if only one of these materials should be specified and the design adjusted.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(1993) Moisture-Density Relations of Soils Using a 10-1b. (4.54 kg) Rammer and a 18-inch (457 mm) Drop

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 29/C 29M	(1997) Bulk Density ("Unit Weight") and Voids in Aggregate

ASTM C 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Course Aggregate
ASTM C 128	(1993) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1996) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 4253	(1993) Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D 4318	(1995a) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E 11	(1995) Wire Cloth Sieves for Testing Purposes

1.2 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.2.1 Base Course

Base course is well graded, crushed, durable aggregate uniformly moistened and mechanically stabilized by compaction. GCA is similar to ABC, but it has more stringent requirements and it produces a base course with higher strength and stability.

1.2.2   Degree of Compaction

****

NOTE: ASTM D 1557 will be used for maximum density determinations, if gradation 3 is used (less than 30% retained on the 19 mm (3/4") sieve). AASHTO T 180, Method D will be used for the maximum density determinations, if gradations 1 or 2 are used (more than 30% retained on the 19 mm (3/4") sieve).

****

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in AASHTO T 180 Method D. Where free draining soils, i.e., sand or gap-graded aggregate are to be compacted, use ASTM D 4253. The procedure will be abbreviated below as a percentage of laboratory density.

1.3   SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Plant, Equipment, and Tools; FIO.

List of proposed equipment to be used in performance of construction work, including descriptive data.

SD-09 Reports

Sampling and testing; GA. Field Density Tests; FIO.

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within 24 hours after the tests are performed. Certified copies of test results for approval not less than 30 days before material is required for the work.

1.4 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by a testing laboratory approved in accordance with Section 01451 CONTRACTOR QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements; testing shall be performed at the specified frequency. The Contracting Officer may specify the time and location of the tests. Copies of test results shall be furnished to the Contracting Officer within 24 hours of completion of the tests.

1.4.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.4.2 Tests

The following tests shall be performed in conformance with the applicable standards listed.

1.4.2.1 Sieve Analysis

****

NOTE: Testing in accordance with ASTM D 422 will be required when the materials need to be tested for frost susceptibility requirements. See paragraph Gradation Requirements.

****

Sieve analysis shall be made in conformance with ASTM C 117 and ASTM C 136. Sieves shall conform to ASTM E 11.

1.4.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.

1.4.2.3 Moisture-Density Determinations

****

NOTE: ASTM D 1557 will be used for maximum density determinations, if gradation 3 is used (less than 30% retained on the 19 mm (3/4") sieve). AASHTO T 180, Method D will be used for the maximum density determinations, if gradations 1 or 2 are used (more than 30% retained on the 19 mm (3/4") sieve).

****

The maximum density and optimum moisture content shall be determined in accordance with AASHTO T 180, Method D as determined in paragraph, Degree of Compaction.

1.4.2.4 Field Density Tests

Density shall be field measured in accordance with ASTM D 1556 or ASTM D

2922. For the method presented in ASTM D 1556 the base plate as shown in the drawing shall be used. For the method presented in ASTM D 2922 the calibration curves shall be checked and adjusted if necessary using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D 2922 result in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration of ASTM D 2922, on each different type of material being tested at the beginning of a job and at intervals as directed. When ASTM D 2922 is used to determine in-place density, there shall be one check test using ASTM D 1556, for every ten (10) nuclear tests taken on the same material.

1.4.2.5 Wear Test

Wear tests shall be made on the base course material in conformance with ASTM C 131.

1.4.3 Soundness

****
NOTE: This paragraph will be omitted when graded-crushed aggregate base course is not included as part of this specification.
****

Soundness tests shall be made on the base course in accordance with ASTM C 88.

1.4.4 Testing Frequency

1.4.4.1 Initial Tests

****
NOTE: The 0.02 mm (No. 635) sieve analysis requirements will be included when frost susceptibility concerns exist.
****

One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

a. Sieve Analysis.

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

d. Wear.

e. Soundness.

1.4.4.2 In Place Tests

One of each of the following tests shall be performed on samples taken from the placed and compacted base course. Samples shall be taken and tested at the rates indicated.

a. Density tests shall be performed on every lift of material placed and at a frequency of one set of tests for every 250 square yards or portion thereof, of completed area.

b. Sieve Analysis shall be performed for every 500 tons, or portion thereof, of material placed.

c. Liquid limit and plasticity index tests shall be performed at the same frequency as the sieve analysis.

1.4.5 Approval of Material

The source of the material shall be selected 30 days prior to the time the material will be required in the work. Tentative approval of material will be based on initial test results. Final approval of the materials will be based on sieve analysis, liquid limit, and plasticity index tests performed on samples taken from the completed and fully compacted base course.

1.5 PLANT, EQUIPMENT, AND TOOLS

****

NOTE: If desirable, requirements for types of equipment applicable to methods of construction based on local conditions will be included.

****

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

PART 2 PRODUCTS

2.1 AGGREGATES

****

NOTE: Material requirements from State or other local highway agency specifications may be incorporated in contract documents for constructing aggregate base course for roads, streets, or similar use pavements if the following conditions are met:

a. Percentage of material by weight passing the 0.075 mm (No. 200) sieve will not exceed 10.

b. Where local conditions dictate a non-frost-susceptible material, particles passing the 0.02 mm (No. 635) sieve will not exceed 3 percent.

c. Portion of the material passing the 0.425 mm (No. 40) sieve must have a liquid limit not greater than 25 and a plasticity index not greater than 5.

d. State or other local highway specifications selected for projects requiring not more than 600 cubic meters (750 cubic yards) of material must be approved by the Division Engineer.

e. State or other local highway specifications selected for projects requiring more than 600 cubic meters (750 cubic yards) must be approved by USACE, TSMCX prior to incorporation in the contract documents. A copy of the specifications or proper reference thereto and information regarding traffic conditions and facilities to be paved will be submitted to the TSMCX, with the request for approval.

f. Materials to be used for GCA must also meet the specified L.A. Abrasion and Magnesium Sulfate Soundness requirements.

g. Rounded aggregates (such as river-run gravel) will not be allowed since they do not provide sufficient interlocking action to produce the desired strengths and durability.

****

The base course shall consist of clean, sound, durable particles of crushed stone, crushed gravel, angular sand, or other approved material. Base course shall be free of silt and clay as defined by ASTM D 2487, organic matter, and other objectionable materials or coatings. The portion retained on the No. 4 sieve shall be known as coarse aggregate; that portion passing the No. 4 sieve shall be known as fine aggregate.

2.1.1 Coarse Aggregate

Coarse aggregates shall be angular particles of uniform density. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements and shall be stockpiled separately.

a. Crushed Gravel: Crushed gravel shall be manufactured by crushing gravels, and shall meet all the requirements specified below.

b. Crushed Stone: Crushed stone shall consist of freshly mined quarry rock, and shall meet all the requirements specified below.

2.1.1.1 Base Course

****

NOTE: The percentages of wear and soundness applicable to the specific job will be specified. A wear value of 40 will be used except that a value up to 50 percent may be used where local experience

indicates that the material is satisfactory. The soundness test is for use in excluding aggregates known to be unsatisfactory and for evaluating aggregates from new sources. The designer will insert in the blank space the applicable loss in percent for the specific job, based on the knowledge of aggregates in the area that have been previously approved and have a satisfactory service record for at least 5 years. The specified values will ensure that aggregates from new sources will be equal to or better than aggregates from known or approved sources.

****

GCA and ABC coarse aggregate shall not show more than 40 percent loss for GCA and 50 percent loss for ABC when subjected to the Los Angeles abrasion test in accordance with ASTM C 131. GCA and ABC coarse aggregate shall not exhibit a loss greater than 50 percent weighted average, at five cycles, when tested for soundness in magnesium sulfate in accordance with ASTM C 88. The amount of flat and elongated particles shall not exceed 20 percent for the fraction retained on the 1/2 inch sieve nor 20 percent for the fraction passing the 1/2 inch sieve. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, the crushed aggregate shall contain at least 90 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the piece. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two fractured faces. Crushed gravel shall be manufactured from gravel particles 90 percent of which by weight are retained on the maximum size sieve listed in TABLE 1.

2.1.2 Fine Aggregate

Fine aggregates shall be angular particles of uniform density. When the fine aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements.

2.1.2.1 Base Course

****

NOTE: The GCA fine aggregate will be entirely the product of crushing, but need not be of the same material crushed for the coarse aggregate. Retain only the statement describing the method of crushing desired.

****

GCA and ABC fine aggregate shall consist of angular particles produced by crushing stone, or gravel that meets the requirements for wear and soundness specified for coarse aggregate. Fine aggregate shall be produced by crushing only particles larger than No. 4 sieve in size. The fine aggregate shall contain at least 90 percent by weight of particles having two or more freshly fractured faces in the portion passing the No. 4 sieve and retained on the No. 10 sieve, and in the portion passing the No. 10 sieve and retained on the No. 40 sieve.

2.1.3   Gradation Requirements

****

NOTE: The gradation or gradations applicable to the specific job will be specified. The maximum size of aggregates will be specified in the blank space. The frost susceptibility requirement will be deleted in areas where the material is not subject to frost action. On the basis of local conditions, the percentage passing the 0.075 mm (No. 200) sieve may be further restricted to help control the amount of particles passing the 0.02 mm (No. 635) sieve. If more than one gradation is maintained, the designer must edit this specification and/or the project drawings to make sure it is evident where these different gradations are to be used.

****

The specified gradation requirements shall apply to the completed base course. The ABC aggregates shall meet the requirements of Hawaii Standard Specifications for Roads, Bridges and Public Works Construction, Section 703.6 and Table 703 IV, 1-1/2 inch maximum and shall be continuously well graded within the following limits, shown in Table 1. The GCA aggregates shall be continuously well graded within the limits shown in Table 2. Sieves shall conform to ASTM E 11.

TABLE I. GRADATION OF AGGREGATES

Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	No. 1
2 inch	100
1-1/2 inch	90-100
3/4 inch	50-90
No. 4	25-50
No. 200	3-9

2.1.4   Liquid Limit and Plasticity Index

****

NOTE: Aggregate should be nonplastic or as nearly so as possible. Values shown are the absolute maximum allowable values for liquid limit and plasticity index.

****

Liquid limit and plasticity index requirements shall apply to the completed course and shall also apply to any component that is blended to meet the required gradation. The portion of any component or of the completed course passing the No. 40 sieve shall be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 6.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the base course is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the working area. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 STOCKPILING MATERIAL

****

NOTE: In cases where material previously stockpiled under a separate contract is utilized in the construction of the base course, this requirement will be included in the specifications. When applicable, a separate item of work will be shown in the bid schedule to provide for the use of previously stockpiled materials.

****

Prior to stockpiling of material, storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas designated by the Contracting Officer to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

3.3 PREPARATION OF UNDERLYING COURSE

****

NOTE: Only the reference to the specification section that covers the preparation of subbase surface for the particular project will be retained; other references will be deleted. The surface of the cohesionless subgrade or subbase may require stabilization prior to placement of the base course. This may be accomplished by compacting a layer of crushed aggregate into the surface. It may also be obtained by methods based on local experience. These methods (e.g., use of cement, lime, bitumen, and chemicals), as well as any stabilization of cohesive materials, will be subject to approval by HQUSACE (CEMP-ET). The additional crushed aggregate will be considered as part of the underlying course and may be paid for or included in the specification section that covers the preparation of subgrade or

subbase for the particular project.
****

Prior to constructing the base course, the underlying course or subgrade shall be cleaned of all foreign substances. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. The underlying course shall conform to [Section 02300 EARTHWORK], [Section 02721 SUBBASE COURSES]. Ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses containing sands or gravels, as defined in ASTM D 2487, the surface shall be stabilized prior to placement of the baase course. Stabilization shall be accomplished by mixing base course into the underlying course and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements of the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the base course is placed.

3.4 INSTALLATION

3.4.1 Mixing the Materials

****
NOTE: More details of applicable methods of placing, mixing, and spreading will be included when appropriate.
****

The coarse and fine aggregates shall be mixed in a stationary plant, or in a traveling plant or bucket loader on an approved paved working area. The Contractor shall make adjustments in mixing procedures or in equipment as directed to obtain true grades, to minimize segregation or degradation, to obtain the required water content, and to insure a satisfactory base course meeting all requirements of this specification.

3.4.2 Placing

The mixed material shall be placed on the prepared subgrade or subbase in layers of uniform thickness with an approved spreader. When a compacted layer 6 inches or less in thickness is required, the material shall be placed in a single layer. When a compacted layer in excess of 6 inches is required, the material shall be placed in layers of equal thickness. No layer shall exceed 6 inches or less than 3 inches when compacted. The layers shall be so placed that when compacted they will be true to the grades or levels required with the least possible surface disturbance. Where the base course is placed in more than one layer, the previously constructed layers shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms, as directed. Such adjustments in placing procedures or equipment shall be made as may be directed to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to insure an acceptable base course.

3.4.3 Grade Control

The finished and completed base course shall conform to the lines, grades, and cross sections shown. Underlying material(s) shall be excavated and prepared at sufficient depth for the required base course thickness so that the finished base course with the subsequent surface course will meet the designated grades.

3.4.4 Edges of Base Course

****

NOTE: The extra width of material is provided for a working platform during construction. This will provide the paving equipment a solid surface to track on and will help ensure a smoother pavement.

****

The base course shall be placed so that the completed section will be a minimum of 5 feet wider, on all sides, than the next layer that will be placed above it. Additionally, approved fill material shall be placed along the outer edges of the base course in sufficient quantities to compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 2 foot width of this material to be rolled and compacted simultaneously with rolling and compacting of each layer of the base course. If this base course material is to be placed adjacent to another pavement section, then the layers for both of these sections shall be placed and compacted along this edge at the same time.

3.4.5 Compaction

****

NOTE: Appropriate percentage will be inserted in the first bracketed blank. Cohesionless materials are often free-draining; as such, the optimum water content is normally limited to the maximum water content the material will retain. This is usually evidenced by free water running from the mold during compaction testing.

****

Each layer of the base course shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within plus or minus 3 percent of the optimum water content determined from laboratory tests as specified in paragraph SAMPLING AND TESTING. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. The speed of the roller shall not be more than 3 mph, and if necessary be adjusted downward so that the displacement of the aggregate does not occur. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Compaction shall continue until each layer has a degree of compaction that is at least 100 percent of laboratory maximum density through the full depth of the layer. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory base course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

3.4.6   Thickness

****
NOTE: When base courses are constructed less than 150 mm (6 inches) in total thickness, a deficiency of 13 mm (1/2 inch) in thickness of any area of such paving is considered excessive. Applicable to job conditions, the thickness-tolerance provisions may be modified as required, restricting all deficiencies to not over 6 mm (1/4 inch).
****

Compacted thickness of the aggregate course shall be as indicated inches. No individual layer shall exceed 8 inches nor be less than 3 inches in compacted thickness. The total compacted thickness of the base course shall be within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 1/4 inch of the thickness indicated. The total thickness of the base course shall be measured at intervals in such a manner as to ensure one measurement for each 500 square yards of base course. Measurements shall be made in 3 inch diameter test holes penetrating the base course.

3.4.7   Proof Rolling

****
NOTE: Drawings should be checked to ensure that any supplementary information required by this paragraph has been shown and that there is no conflict between the drawings and the specifications.

Proof rolling is only applicable for flexible airfield pavement (see TM 5-825-2). This paragraph will be deleted from all project specifications for courses under road pavement and under rigid airfield pavement unless it is specifically required by the design engineer. Proof rolling is not needed for airfield shoulder pavements.
****

Proof rolling of the areas indicated shall be in addition to the compaction specified and shall consist of the application of 30 coverages with a heavy pneumatic-tired roller having four or more tires, each loaded to a minimum of 30,000 pounds and inflated to a minimum of 150 psi. In areas designated, proof rolling shall be applied to the top of the underlying material on which GCA is laid and to each layer of GCA. Water content of the underlying material shall be maintained at optimum or at the percentage directed from start of compaction to completion of proof rolling of that layer. Water content of each layer of the GCA shall be maintained at the optimum percentage directed from start of compaction to completion of proof rolling. Any GCA materials or any underlying materials that produce unsatisfactory results by proof rolling shall be removed and replaced with satisfactory materials, recompacted and proof rolled to meet these specifications.

3.4.8 Finishing

The surface of the top layer of the base course shall be finished after final compaction and proof rolling by cutting any overbuild to grade and rolling with a steel-wheeled roller. Thin layers of material shall not be added to the top layer of base course to meet grade. If the elevation of the top layer of GCA is 1/2 inch or more below grade, then the top layer should be scarified to a depth of at least 3 inches and new material shall be blended in compacted and proof rolled to bring to grade. Adjustments to rolling and finishing procedures shall be made as directed to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, the unsatisfactory portion shall be scarified, reworked and recompacted or it shall be replaced as directed.

3.4.9 Smoothness

The surface of the top layer shall show no deviations in excess of 3/8 inch when tested with a [10] [12] foot straightedge. Measurements shall be taken in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at [50] [_____] foot intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.5 TRAFFIC

****

NOTE: Traffic will not be allowed on any base course placed for airfield pavements. For roads, traffic should only be allowed on the base courses when it cannot be diverted elsewhere; but precautions should be taken to limit the traffic and keep heavy equipment off. Any damage caused by traffic should be repaired to meet these specification requirements. Designer will choose the appropriate bracketed information.

****

Traffic shall not be allowed on the completed base course.

3.6 MAINTENANCE

The GCA shall be maintained in a satisfactory condition until the full pavement section is completed and accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any GCA that is not paved over prior to the onset of winter, shall be retested to verify that it still complies with the requirements of this specification. Any area of GCA that is damaged shall be reworked or replaced as necessary to comply with this specification.

3.7 DISPOSAL OF UNSATISFACTORY MATERIALS

Any unsuitable materials that must be removed shall be disposed of as directed. No additional payments will be made for materials that must be replaced.

-- End of Section --

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DEPARTMENT OF THE ARMY **HED-02741 (February 2000)**
U.S. ARMY CORPS OF ENGINEERS **---------------------------**
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SECTION 02741

BITUMINOUS PAVING FOR ROADS, STREETS AND OPEN STORAGE AREAS
02/00

****
NOTE: This guide specification covers the requirements for bituminous intermediate and wearing courses (central-plant hot-mix). This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-700.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 29/C 29M	(1997) Bulk Density (Unit Weight) and Voids in Aggregate
ASTM C 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 117	(1995) Materials Finer than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	(1993) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 183	(1995a) Sampling and the Amount of Testing of Hydraulic Cement
ASTM D 5	(1995) Penetration of Bituminous Materials
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 242	(1995) Mineral Filler for Bituminous Paving Mixtures
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 946	(1982; R 1993) Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 1250	(1980; R 1997) Petroleum Measurement Tables
ASTM D 1559	(1989) Resistance to Plastic Flow of Bituminous Mixture Using Marshall Apparatus
ASTM D 1856	(1995a) Recovery of Asphalt from Solution by Abson Method
ASTM D 2041	(1995) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 2172	(1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil and Rock

ASTM D 2726	(1996a) Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixture
ASTM D 3381	(1992) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	(1996) Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
ASTM D 4791	(1995) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

STATE OF HAWAII

	(1994) Hawaii Standards Specification for Roads, Bridge and Public Works Construction

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-09 Reports

Bituminous Pavement; GA.

Copies of test results.

SD-14 Samples

Bituminous Pavement; FIO.

Samples of the materials in the quantities indicated below for the job mix formula.

Aggregate and mineral filler (if needed) to be blended in approximately the same proportions as used in the project	200 pounds
Asphalt Cement	5 gallons

Aggregate samples when new sources are developed, with a plan for operation, 30 days before starting production. Samples of the asphalt cement specified, not less than 30 days before production.

1.3 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.3.1 General

The bituminous plant shall be of such capacity to produce the quantities of bituminous mixtures required. Hauling equipment, paving machines, rollers, miscellaneous equipment, and tools shall be provided in sufficient numbers and capacity and in proper working condition to place the bituminous paving mixtures at a rate equal to the plant output.

1.3.2 Mixing Plants

****

NOTE: The minimum plant capacity depends on the size of job and time requirements; however, in no case should the plant capacity be less than 100 metric tons (tons) per hour. When the job is less than 1,000 metric tons (tons), the Contractor may be required to do all testing including mix design.

****

The mixing plant shall be an automatic or semiautomatic controlled commercially manufactured unit designed and operated to consistently produce a mixture within the job-mix formula (JMF). The plant shall have a minimum capacity of 100 tons per hour. Drum mixers shall be prequalified at the production rate to be used during actual mix production. The prequalification tests will include extraction and recovery of the asphalt cement in accordance with ASTM D 2172 and ASTM D 1856. The penetration of the recovered asphalt binder shall not be less than 60 percent of the original penetration, as measured in accordance with ASTM D 5.

1.3.3 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 12-foot straightedge for each bituminous paver. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to ensure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

1.4 WEATHER LIMITATIONS

Bituminous courses shall not be placed on any wet surfaces, or when weather conditions otherwise prevent the proper handling or finishing of the bituminous course.

1.5 PROTECTION OF PAVEMENT

After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until the pavement has cooled to 140 degrees F.

1.6 GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS

Finished surface of bituminous courses, when tested as specified below and in paragraph ACCEPTABILITY OF WORK, shall conform to gradeline and elevations shown and to surface-smoothness requirements specified.

1.6.1 Plan Grade

The grade of the completed surface shall not deviate more than 0.05 foot from the plan grade.

1.6.2 Surface Smoothness

When a 12-foot straightedge is laid on the surface parallel with the centerline of the paved area or transverse from crown to pavement edge, the surface shall vary not more than 1/4 inch from the straightedge.

1.7 GRADE CONTROL

Lines and grades shall be established and maintained by means of line and grade stakes placed at site of work in accordance with the Special Contract Requirements. Elevations of bench marks used by the Contractor for controlling pavement operations at the site of work will be determined, established, and maintained by the Government. Finished pavement elevations shall be established and controlled at the site of work by the Contractor in accordance with bench mark elevations furnished by the Contracting Officer.

1.8 SAMPLING AND TESTING

1.8.1 Aggregates

1.8.1.1 General

Samples of aggregates shall be furnished by the Contractor for approval of aggregate sources and stockpiles prior to the start of production and at times during production of the bituminous mixtures. Times and points of sampling will be designated by the Contracting Officer. Samples will be the basis of approval of specific sources or stockpiles of aggregates for aggregate requirements. Unless otherwise directed, ASTM D 75 shall be used in sampling coarse and fine aggregate, and ASTM C 183 shall be used in sampling mineral filler. All tests necessary to determine compliance with requirements specified herein will be made by the Contractor.

1.8.1.2 Sources

****

NOTE: Satisfactory service record for an aggregate will be determined based on the aggregate's ability to resist polishing, raveling, stripping, and degradation under traffic and climatic conditions similar to that expected during its use. If performance data indicate that an aggregate is susceptible to one or more of the above-mentioned problems, that source of aggregate shall be rejected.

****

Sources of aggregates shall be selected well in advance of the time the materials are required in the work. If a previously developed source is selected, evidence shall be submitted 60 days before starting production, indicating that the central-plant hot-mix bituminous pavements constructed with the aggregates have had a satisfactory service record of at least five years under similar climatic and traffic conditions. The Contractor will make such tests and other investigations as necessary to determine whether aggregates meeting requirements specified herein can be produced from proposed sources. If a sample of material from a new source fails to meet specification requirements, the material represented by the sample shall be replaced, and the cost of testing the replaced sample will be at the expense of the Contractor. Approval of the source of aggregate does not relieve the Contractor of responsibility for delivery at the jobsite of aggregates that meet the requirements specified herein.

1.8.2 Bituminous Materials

Samples of bituminous materials shall be obtained by the Contractor; sampling shall be in accordance with ASTM D 140. Tests necessary to determine conformance with requirements specified herein will be performed by the Contractor without cost to the Government. Sources where bituminous materials are obtained shall be selected in advance of the time when materials will be required in the work. In addition to initial qualification testing of bituminous materials, samples shall be taken before and during construction when shipments of bituminous materials are received or when necessary to assure some condition of handling or storage has not been detrimental to the bituminous material. The samples will be taken and tested by the Contractor.

1.8.3 Bituminous Mixtures

Sampling and testing of bituminous mixtures will be accomplished by the Contractor.

1.9 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.9.1 Mineral Aggregates

Mineral aggregates shall be delivered to the site of the bituminous mixing plant and stockpiled in such manner as to preclude fracturing of aggregate particles, segregation, contamination, or intermingling of different materials in the stockpiles or cold-feed hoppers. Mineral filler shall be delivered, stored, and introduced into the mixing plant in a manner to preclude exposure to moisture or other detrimental conditions.

1.9.2 Bituminous Materials

Bituminous materials shall be maintained at appropriate temperature during storage but shall not be heated by application of direct flame to walls of storage tanks or transfer lines. Storage tanks, transfer lines, and weigh buckets shall be thoroughly cleaned before a different type or grade of bitumen is introduced into the system. The asphalt cement shall be heated sufficiently to allow satisfactory pumping of the material; however, the storage temperature shall be maintained below 300 degrees F.

1.10 ACCESS TO PLANT AND EQUIPMENT

The Contracting Officer shall have access at all times to all parts of the paving plant for checking adequacy of the equipment in use; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking temperatures maintained in preparation of the mixtures.

PART 2   PRODUCTS

2.1   BITUMINOUS HOT MIX

Bituminous hot mix shall consist of coarse aggregate, fine aggregate, mineral filler, bituminous material, and approved additives, if required, of the qualities and in the proportions specified and shall conform to the requirements contained in paragraphs PROPORTIONING OF MIXTURE and ACCEPTABILITY OF WORK.

2.1.1   Aggregates

****

NOTE: Appropriate gradations from Table 703-V, Hawaii Standard Specifications for Road, Bridge, and Public Works Construction, will be listed in Table I.

****

Aggregates shall manufactured by crushing and screening hard, tough, durable basalt rock. The finished product shall be free from soft or disintegrated pieces, clay, dirt, or other deleterious substances.

TABLE I. AGGREGATE GRADATION

Mix No. Sieve Size	Binder Course III Percent Passing	Binder/Surface Course IV Percent Passing	Surface Course A.C Curb V
1"	100		
3/4"	90-100	100	
1/2"	70-90	85-100	100
3/8"	-	72-88	80-100
No. 4	40-57	48-66	55-75
No. 8	30-47	32-48	35-52
No. 16	20-36	21-37	22-38
No. 30	16-28	15-27	14-26
No. 50	10-22	9-21	8-20
No. 100	8-17	6-16	6-15
No. 200	4-10	4-10	4-10
Asphalt, (% dry weight of mixture	4.5-6.5	4.5-6.6	5.0-7.5

2.1.1.1 Coarse Aggregate

****

NOTE: The values of percentage of loss will be based on knowledge of aggregates in the area that have been previously approved or that have a satisfactory service record in bituminous pavement construction for at least 5 years.

****

Coarse aggregate shall meet the requirements of Section 703.09, Aggregates for Hot Plant Mix Bituminous Pavement of the Hawaii Standard Specifications for Road and Bridge Construction.

2.1.1.2 Fine Aggregate

Fine aggregate shall consist of clean, sound, durable particles, including natural sand or crushed stone or gravel that meets requirements for wear and soundness specified for coarse aggregate. Fine aggregate produced by crushing gravel shall have at least 90 percent by weight of crushed particles having two or more fractured faces in the portion retained on the No. 30 sieve. This requirement shall apply to the material before blending with natural sand when blending is necessary. Quantity of natural sand to be added to the wearing- and intermediate-course mixtures shall not exceed 25 percent by weight of coarse and fine aggregate and material passing the No. 200 sieve. Natural sand shall be clean and free from clay and organic matter.

2.1.1.3 Mineral Filler

****
NOTE: In areas where there is a possibility that dune sand or one-size material may be used as mineral filler, the following bracketed gradation requirements will be used to eliminate undesirable one-size materials.
****

Mineral filler shall conform to ASTM D 242.

Grain size in mm	Percent Finer
0.05	70-100
0.02	35-65
0.005	10-22

Grain size shall be determined in accordance with ASTM D 422.

2.1.2 Bituminous Material

****
NOTE: The appropriate types and grades of bituminous materials for the pavement's use and climatic environment should be used. (Refer to TM 5-822-8/AFM 88-6, Chapters 2 and 9.) Military roads to be used by tracked vehicles will be designed for tire pressures of 1.38 MPa (200 psi) and above. Requirements of ASTM D 946 should be used to specify penetration-graded asphalt cement, or ASTM D 3381 for viscosity-graded asphalt cement.
****

Asphalt cement shall conform to ASTM D 946 Viscosity, Grade AR-80.

2.1.3 Additives

The use of additives such as antistripping and antifoaming agents is subject to approval.

2.2 PROPORTIONING OF MIXTURE

****
NOTE: The quantity of materials specified should be adequate for determination of acceptability of source and determination of the JMF. Adjust quantity if circumstances require more material. The procedures for determining the JMF to be used in the mixtures are described in TM 5-822-8/AFM 88-6, Chapters 2 and 9. Proportioning of the aggregates for the JMF should be carefully determined because the gradations will be those on which the Contractors' tolerances will be applied. Application of these tolerances may cause the gradation to be outside the limits of the gradation

in the specification, but this is acceptable. Only those columns in TABLES III and IV showing test properties that are applicable to the project will be retained.
****

2.2.1 Job Mix Formula

The JMF for the bituminous mixture will be furnished by the Contractor for approval by the Contracting Officer. Blending of the aggregates will be accomplished by the Contractor. No payment will be made for mixtures produced prior to the approval of the JMF. The formula will indicate the percentage of each stockpile and mineral filler, the percentage of each size aggregate, the percentage of bitumen, and the temperature of the completed mixture when discharged from the mixer. Tolerances are given in TABLE II for asphalt content, temperature, and aggregate grading for tests conducted on the mix as discharged from the mixing plant; however, the final evaluation of aggregate gradation and asphalt content will be based on paragraph ACCEPTABILITY OF WORK. Bituminous mix that deviates more than 25 degrees F from the JMF shall be rejected.

TABLE II. JOB-MIX TOLERANCES

Material	Tolerance, Plus or Minus
Aggregate passing No. 4 sieve or larger	7 percent above or below
Aggregate passing Nos. 8 and 100 sieves (inclusive)	4 percent above or below
Aggregate passing No. 200 sieve	2 percent above or below
Bitumen	0.4 percent above or below
Temperature of mixing	20 degrees F or below

Percentage of bitumen in the mixture shall be determined by the Contractor in accordance with ASTM D 2172.

2.2.2 Test Properties of Bituminous Mixtures

****
NOTE: Consult CEMP-ET on test method to be used and include in this paragraph and subparagraphs below.
****

Finished mixture shall meet requirements described below when tested in accordance with ASTM D 1559. All samples will be compacted with 50 blows of specified hammer on each side of sample. When bituminous mixture fails to meet the requirements specified below, the paving operation shall be stopped until the cause of noncompliance is determined and corrected.

2.2.2.1 Stability, Flow, and Voids

The bituminous mixture shall meet the requirements of Section 401.02 and Section 703.09 of the Hawaii Standard Specifications for Road and Bridge Construction with the following exceptions: Stability, flow and shall be determined in accordance with ASTM D 1559. The mixture voids shall have a stability of at least 500, a flow not to exceed 20, voids total mix of 4% to 6%, and voids filled with bitumen to 64% and 75%.

PART 3   EXECUTION

3.1   BASE COURSE CONDITIONING

****

NOTE: The type of base course on which the bituminous intermediate and/or wearing courses are to be constructed will be inserted in the blanks. If project does not involve construction of bituminous courses on base course, delete this paragraph.

****

The surface of the base course will be inspected for segregated or boney areas, adequate compaction and surface tolerances specified in Section 02722 AGGREGATE AND/OR GRADED-CRUSHED AGGREGATE BASE COURSE. Unsatisfactory areas shall be corrected. no bituminous material of any type will be placed on the surface of the base course until all deficiencies have been corrected.

3.2   EXISTING PAVEMENT CONDITIONING

****

NOTE: Appropriate statements covering the required conditioning of the existing pavement will be inserted.

****

3.3   PREPARATION OF BITUMINOUS MIXTURES

Rates of feed of aggregates shall be regulated so that the moisture content and temperature of aggregates will be within specified tolerances. Aggregates, mineral filler, and bitumen shall be conveyed into the mixer in proportionate quantities required to meet the JMF. Mixing time shall be as required to obtain a uniform coating of the aggregate with the bituminous material. Temperature of bitumen at time of mixing shall not exceed 300 degrees F. Temperature of aggregate and mineral filler in the mixer shall not exceed 325 degrees F when bitumen is added. Overheated and carbonized mixtures or mixtures that foam shall not be used.

3.4   WATER CONTENT OF AGGREGATES

Drying operations shall reduce the water content of mixture to less than 0.75 percent. The water content test will be conducted in accordance with ASTM D 2216; the weight of the sample shall be at least 500 grams. If the water content is determined on hot bin samples, the water content will be a weighted average based on composition of blend.

3.5   STORAGE OF BITUMINOUS PAVING MIXTURE

Storage shall conform to the applicable requirements of ASTM D 3515; however, in no case shall the mixture be stored for more than 4 hours.

3.6 TRANSPORTATION OF BITUMINOUS MIXTURE

Transportation from paving plant to site shall be in trucks having tight, clean, smooth beds lightly coated with an approved releasing agent to prevent adhesion of the mixture to the truck bodies. Excessive releasing agent shall be drained prior to loading. Each load shall be covered with canvas or other approved material of ample size to protect mixture from weather and to prevent loss of heat. Loads that have crusts of cold, unworkable material or that have become wet will be rejected. Hauling over freshly placed material will not be permitted.

3.7 SURFACE PREPARATION OF UNDERLYING COURSE

Prior to placing of the intermediate or wearing course, the underlying course shall be cleaned of all foreign or objectionable matter with power brooms and hand brooms.

3.8 PRIME COATING

****

NOTE: If project does not involve construction of bituminous courses on base course, delete this paragraph.

****

Surfaces of previously constructed base course shall be sprayed with a coat of bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS.

3.9 TACK COATING

Contact surfaces of previously constructed pavement, curbs, manholes, and other structures shall be sprayed with a thin coat of bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS.

3.10 PLACING

Bituminous courses shall be constructed only when the base course or existing pavement has no free water on the surface. Bituminous mixtures shall not be placed without ample time to complete spreading and rolling during daylight hours, unless approved satisfactory artificial lighting is provided.

3.10.1 Offsetting Joints

The wearing course shall be placed so that longitudinal joints of the wearing course will be offset from joints in the intermediate course by at least 1 foot. Transverse joints in the wearing course shall be offset by at least 2 feet from transverse joints in the intermediate course.

3.10.2 General Requirements for Use of Mechanical Spreader

Range of temperatures of mixtures, when dumped into the mechanical spreader, shall be as determined by the Contracting Officer. Mixtures having temperatures less than 225 degrees F when dumped into the mechanical spreader shall not be used. The mechanical spreader shall be adjusted and the speed regulated so that the surface of the course being laid will be smooth and continuous without tears and pulls, and of such depth that, when compacted, the surface will conform to the cross section indicated. Placing with respect to center line areas with crowned sections or high side of areas with one-way slope shall be as directed. Each lot of material placed shall conform to requirements specified in paragraph ACCEPTABILITY OF WORK. Placing of the mixture shall be as nearly continuous as possible, and speed of placing shall be adjusted, as directed, to permit proper rolling. When segregation occurs in the mixture during placing, the spreading operation shall be suspended until the cause is determined and corrected.

3.10.3 Placing Strips Succeeding Initial Strips

In placing each succeeding strip after initial strip has been spread and compacted as specified below, the screed of the mechanical spreader shall overlap the previously placed strip 2 to 3 inches and be sufficiently high so that compaction produces a smooth dense joint. Mixture placed on the edge of a previously placed strip by the mechanical spreader shall be pushed back to the edge of the strip by use of a lute. Excess mixture shall be removed and wasted.

3.10.4 Handspreading in Lieu of Machine Spreading

In areas where the use of machine spreading is impractical, the mixture shall be spread by hand. Spreading shall be in a manner to prevent segregation. The mixture shall be spread uniformly with hot rakes in a loose layer of thickness that, when compacted, will conform to required grade, density, and thickness.

3.11 COMPACTION OF MIXTURE

Rolling shall begin as soon after placing as the mixture will bear a roller without undue displacement. Rollers shall not exceed 3 MPH. Delays in rolling freshly spread mixture will not be permitted. After initial rolling, preliminary tests of crown, grade, and smoothness shall be made by the Contractor. Deficiencies shall be corrected so that the finished course will conform to requirements for grade and smoothness specified herein. Crown, grade, and smoothness will be checked in each lot of completed pavement by the Contracting Officer for compliance and will be evaluated as specified in paragraph ACCEPTABILITY OF WORK. After the Contractor is assured of meeting crown, grade, and smoothness requirements, rolling shall be continued until a mat density of at least 92 percent and a joint density of at least 90 percent of maximum as determined in accordance with ASTM D 2041. The density will be determined and evaluated as specified in paragraph ACCEPTABILITY OF WORK. Places inaccessible to rollers shall be thoroughly compacted with hot hand tampers.

3.11.1 Testing of Mixture

For every four hours asphalt production and paving operations, or fraction thereof, a following day, a set of three 4-inch diameter cores shall be obtained from each of the four-hour paving operation. One core shall be on a longitudinal joint and two cores shall be on paving lanes. Cores shall be tested in accordance with ASTM D 2726 and the theoretical maximum specific gravity (ASTM D 2041) determined the day before for the same area will be used to determine pavement density. All sampling and testing will be done by the Contractor at his expense. Locations where samples are to be taken will be determined by the Contracting Officer's Representative.

All completed test results shall be furnished to the Contracting Officer within 24 hours of completing the tests. Summary of test results without all backup data will not be acceptable. Additional cores shall be furnished to the Government for testing by the Government. The number of core samples shall be 5 percent of the number of core samples required for quality control testing rounded off to the next whole number. Location of the core samples will be determined by the Contracting Officer's representative.

3.11.2 Correcting Deficient Areas

Mixtures that become contaminated or are defective shall be removed to the full thickness of the course. Edges of the area to be removed shall be cut so that sides are perpendicular and parallel to the direction of traffic and so that the edges are vertical. Edges shall be sprayed with bituminous materials conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS. Fresh paving mixture shall be placed in the excavated areas in sufficient quantity so that the finished surface will conform to grade and smoothness requirements. Paving mixture shall be compacted to the density specified herein. Skin patching of an area that has been rolled shall not be permitted.

3.12 JOINTS

3.12.1 General

Joints between old and new pavements, between successive work days, or joints that have become cold (less than 175 degrees F) shall be made to ensure continuous bond between the old and new sections of the course. All joints shall have the same texture and smoothness as other sections of the course. Contact surfaces of previously constructed pavements coated by dust, sand, or other objectionable material shall be cleaned by brushing or shall be cut back as directed. When directed by the Contracting Officer, the surface against which new material is placed shall be sprayed with a thin, uniform coat of bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS. Material shall be applied far enough in advance of placement of a fresh mixture to ensure adequate curing. Care shall be taken to prevent damage or contamination of the sprayed surface.

3.12.2 Transverse Joints

The roller shall pass over the unprotected end of a strip of freshly placed material only when placing is discontinued or delivery of the mixture is interrupted to the extent that the material in place may become cold. In all cases, prior to continuing placement, the edge of previously placed pavement shall be cut back to expose an even vertical surface for full thickness of the course. In continuing placement of a strip, the mechanical spreader shall be positioned on the transverse joint so that sufficient hot mixture will be spread to obtain a joint after rolling that conforms to the required density and smoothness specified herein.

3.12.3 Longitudinal Joints

Edges of a previously placed strip shall be prepared such that the pavement in and immediately adjacent to the joint between this strip and the succeeding strip meets the requirements for grade, smoothness, and density specified in paragraph ACCEPTABILITY OF WORK.

3.13 ACCEPTABILITY OF WORK

3.13.1   General

****

NOTE: The lot size can be specified on the basis of time (i.e., 4 hours, 1 day, etc.) or amount of production (i.e., 500 tons, 1000 tons, etc.). If the lot size is based on the amount of production, it should be selected to be approximately equal to the amount of asphalt mix produced in one day's operation. The lot size should not exceed 2000 tons of asphalt mix. If the asphalt pavement is bid on a line item basis as Job Sum, the percent payment is applied to the line item price. The paragraph will be edited accordingly.

(The requirements of this paragraph may be deleted for airfield and heavy-duty road and street projects of less than 1,000 tons, and for projects for medium to light-duty roads and streets of less than 5,000 tons; however, the value of requiring Government quality assurance testing on projects having asphaltic concrete tonnages which fall below the stated minimums should be reviewed on an individual basis for the cost/benefit of the testing.)

****

A lot shall be that quantity of construction that will be evaluated for compliance with specification requirements. A lot shall be equal to hours of production. The Contractor will conduct all initial acceptance tests. Additional tests required to determine acceptability of nonconforming material will be performed by the Contractor at no cost to the government.

3.13.1.1   Lot Evaluation

****

NOTE: Consult CEMP-ET on test method to be used and include below.

****

In order to evaluate aggregate gradation, asphalt content, and density, each lot shall be divided into four equal sublots. For density determination, one random sample shall be taken from the mat, and one random sample shall be taken from the joint of each sublot. A coring machine will be used for taking mat and joint samples from the completed pavement. Core samples will be taken with the coring machine centered over the joint. After air drying to a constant weight, random samples located by the Contracting Officers Representative shall be obtained from the mat shall be used for density determination. Samples for determining asphalt content and aggregate gradation shall be taken from loaded trucks within each sublot. Asphalt content shall be determined in accordance with ASTM D 2172, Method A or B. Aggregate gradation shall be determined for the mix by testing the recovered aggregate in accordance with ASTM C 136 and ASTM C 117.

3.13.1.2   Lot Failure

When a lot of material fails to meet the specification requirements, that lot shall be removed and replaced or accepted at a reduced price. The lowest percent payment for any pavement characteristic (i.e., gradation, asphalt content, density, grade, and smoothness) defined below shall be the percent payment for that lot. The percent payment is based on the pavement characteristics and the contract unit price.

3.13.1.3 Optional Sampling and Testing

The Contracting Officer reserves the right to sample and test any area which appears to deviate from the specification requirements. Testing in these areas will be in addition to the lot testing, and the requirements for these areas will be the same as those for a lot. Additional tests shall be performed by the Contractor at no cost to the Government.

3.13.2 Aggregate Gradation

The mean absolute deviation of the four sublot aggregate gradations from the JMF for each sieve size will be evaluated and compared with TABLE V. The percent payment based on aggregate gradation shall be the lowest value determined for any sieve size in TABLE V. All tests for aggregate gradation will be completed and reported within 24 hours after completion of construction of each lot. The computation of mean absolute deviation for one sieve size is illustrated below:

Example: Assume the following JMF and sublot test results for aggregate gradation

		Percent by Weight Passing Sieves			
Sieve Size	JMF	Test No. 1	Test No. 2	Test No. 3	Test No. 4
3/4 inch	100	100	100	100	100
1/2 inch	88	87	88	90	88
3/8 inch	75	72	77	78	74
No. 4	64	60	65	67	62
No. 8	53	50	56	57	52
No. 16	42	39	44	45	41
No. 30	32	30	34	35	32
No. 50	20	17	20	22	21
No. 100	10	8	10	10	11
No. 200	6	4	7	8	6

Mean Absolute Deviation (for No. 200 sieve) = ((Absolute value of 4-6) + (Absolute value of 7-6) + (Absolute value of 8-6) + (Absolute value of 6-6))/4 = (2 + 1 + 2 + 0)/4 = 1.25

The mean absolute deviation for other sieve sizes can be determined in a similar way for this example to be:

Sieve Size	3/4 inch	1/2 inch	3/8 inch	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
Mean Absolute Deviation	0	0.75	2.25	2.50	2.75	2.25	1.75	1.50	0.75	1.25

The least percent payment based on any sieve size listed in TABLE V would be 98 percent for the No. 200 sieve. Therefore, for this example the percent payment based on aggregate gradation is 98 percent.

TABLE V. PERCENT PAYMENT BASED ON MEAN ABSOLUTE DEVIATION OF AGGREGATE GRADATIONS FROM JMF

Sieve Size	Percent Payment Based On Mean Absolute Deviation from JMF 0.0-1.0	1.1-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	Above 6.0
3/4 inch	100	100	100	100	98	95	90
1/2 inch	100	100	100	100	98	95	90
3/8 inch	100	100	100	100	98	95	90
No. 4	100	100	100	100	98	95	90
No. 8	100	100	100	98	95	90	reject
No. 16	100	100	100	98	95	90	reject
No. 30	100	100	100	98	95	90	reject
No. 50	100	100	100	98	95	90	reject
No. 100	100	98	95	90	90	reject	reject
No. 200	100	98	90	reject	reject	reject	reject

3.13.3 Asphalt Content

The mean absolute deviation of the four asphalt contents from the JMF will be evaluated and compared with TABLE VI. The percent payment based on asphalt content shall be the value determined in TABLE VI. Asphalt content tests shall be completed and reported within 24 hours after construction of the lot.

TABLE VI. PERCENT PAYMENT BASED ON ASPHALT CONTENT

Mean Absolute Deviation of Extracted Asphalt Content from JMF	Percent Payment
less than 0.25	100
0.25-0.30	98
0.31-0.35	95
0.36-0.40	90
above 0.40	reject

3.13.4 Density

****
NOTE: Consult CEMP-ET on test method to be used and include below.
****

The average mat and joint densities will be expressed as a percentage of the laboratory density. The laboratory density for each lot will be determined from four sets of laboratory samples. One sample will be obtained from each of the four sublots and will be divided into three specimens to produce one set of laboratory samples. Laboratory samples will be prepared from asphalt mixture which has not been reheated. Samples will be compacted at 250 degrees F within 2 hours of the time the mixture was prepared at the asphalt plant.

3.13.4.1 Field Density

The field density will be determined and compared with TABLE VII. The percent payment based on density shall be the lowest value determined from TABLE VII. The percent payment based on mat density will be for all of the material placed in the lot. The percent payment based on joint density will be for the amount of material represented by an area equal to the lot joint length by 10 feet wide not to exceed the lot size.

TABLE VII. PERCENT PAYMENT BASED ON DENSITY

Average Mat Density (4 cores) Less Than	OR	Greater Than	Percent Payment	Average Joint Density (4 cores) Less Than	OR	Greater Than
91.0	OR	95.0	100.0	89.0	OR	95.0
90.9	OR	95.1	100.0	88.9		
90.8	OR	95.1	99.9	88.8		
90.7	OR	95.2	99.8	88.7		
90.6	OR	95.2	99.6	88.6		
90.5	OR	95.3	99.4	88.5		
90.4	OR	95.3	99.1	88.4		
90.3	OR	95.4	98.7	88.3		
90.2	OR	95.4	98.3	88.2		
90.1	OR	95.5	97.8	88.1		
89.0	OR	95.5	97.3	88.0		
89.9	OR	95.6	96.3	87.9		
89.8	OR	95.6	94.1	87.8		
89.7	OR	95.7	92.2	87.7		
89.6	OR	95.7	90.3	87.6		
89.5	OR	95.8	87.9	87.5		
89.4	OR	95.8	85.7	87.4		
89.3	OR	95.9	83.3	87.3		
89.2	OR	95.9	80.6	87.2		
89.1	OR	96.0	78.0	87.1		
89.0	OR	96.1	reject	87.0		
<89.1	OR	96.1	reject	<87.0		

3.13.4.2 Lot Density

All density results on a lot will be completed and reported within 24 hours after construction of that lot. When the Contracting Officer considers it necessary to take additional samples for density measurements, samples will be taken in groups of four (one for each sublot). The percent payment will be determined for each additional group of four samples and averaged with the percent payment for the original group to determine the final percent payment. The Contractor shall fill all sample holes with hot mix and compact.

3.13.5 Grade

Grade-conformance tests will be conducted by the Government. The finished surface of the pavement will be tested for conformance with plan-grade requirements. Within 5 working days after completion of placement of a particular lot, the Contracting Officer will inform the Contractor in writing of results of grade-conformance tests. The finished grade of each pavement area shall be determined by running lines of levels at intervals of 25 feet or less longitudinally and transversely to determine the elevation of the completed pavement. When more than 5 percent of all measurements made within a lot are outside the tolerances specified in paragraph GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS, the payment for that lot will not exceed 95 percent of the bid price. In areas where the grade exceeds the plan-grade tolerances given in paragraph GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS by more than 50 percent, the Contractor shall remove the deficient area and replace with fresh paving mixture at no additional cost to the Government. Sufficient material shall be removed to allow at least 1 inch of asphalt concrete to be placed. Skin patching for correcting low areas or planing for correcting high areas shall not be permitted.

3.13.6 Surface Smoothness

After completion of final rolling of a lot, the compacted surface will be tested by the Contracting Officer with a 12-foot straightedge. Measurements will be made perpendicular to and across all mats at distances along the mat not to exceed 25 feet. Location and deviation from straightedge of all measurements will be recorded. When more than 5 percent of all measurements along the mat within a lot exceed the specified tolerance, the unit price for that lot shall not exceed 95 percent of the bid price. Any joint or mat area surface deviation which exceeds the tolerance given in paragraph GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS by more than 50 percent shall be corrected to meet the specification requirements. The Contractor shall remove the deficient area and replace with fresh paving mixture at no additional cost to the Government. Sufficient material shall be removed to allow at least 1 inch of asphalt concrete to be placed. Skin patching for correcting low areas or planing for correcting high areas shall not be permitted.

3.14 ASPHALT CONCRETE CURB

3.14.1 General

The asphaltic concrete for curbing shall conform to the Table I; Mix No. V; except that the asphalt content shall be 6.0-8.0 percent.

3.14.2 Equipment and Tools

3.14.2.1 Machine

Machine shall be automatic curbing machine equipped with motor worm gear or screw which pushes the mixture out through the mold form under pressure. The pressure shall provide curb compaction and finish the curb in one continuous operation. Curbing machine shall be subject to the approval of the Contracting Officer.

3.14.2.2 Miscellaneous Tools

Miscellaneous tools and forms, including hand tools, shall be of the type suitable for making asphalt curbs. Tools and forms shall be subject to the approval of the Contracting Officer.

3.14.3 Preparation of Surfaces

Prior to placing curb, the underlying pavement surface shall be cleaned of foreign and objectionable matter and a light uniform coating of hot asphalt conforming to paragraph BITUMINOUS MATERIALS shall be applied before placing the asphalt curb. Application of a heavy coat will not be permitted.

3.14.4 Placing

3.14.4.1 Machine Placing

The placement temperature of the asphaltic mixture for curbing shall not exceed 265 degrees F. The motor shall be stopped while waiting for trucks since vibration form the idling machine may cause the in-place curb under the machine to mush and flatten out causing a depression in the curb. The hopper shall be completely empty while the machine is not in operation. In areas where it is evident that compaction is inadequate, the mix may be adjusted, the machine loaded with additional weights, or other measures taken, as required and as approved to provide the compaction specified hereinafter.

3.14.4.2 Hand Placing

At locations where machine placing is impractical, the mixture may be placed by hand using forms. The material shall be compacted by vibrating compaction or hand tamping. Hand-placed curbs may be constructed only at locations approved by the Contracting Officer.

3.14.5 Compaction of Mixture

The mixture shall be compacted to obtain a density of at least 91 percent of theoretical maximum density. The theoretical density shall be determined as specified hereinbefore. Improperly compacted mixtures shall be removed, replaced with fresh mixtures and compacted to the density specified hereinabove at no additional cost to the Government.

3.14.6 Joints

Contact surfaces of previously constructed curb shall be painted with a light uniform coating of hot asphalt, just prior to placing the fresh curb material to the old joint. Joints shall be provided only between successive days work.

3.14.7 Curing

The newly laid curb shall be protected from traffic by barricade or other suitable method until heat of the asphalt mixture had dissipated and the mixture has obtained its proper degree of hardness. Any curbing damaged prior to final acceptance shall be removed and replaced with new curbing and curing using materials and methods specified hereinbefore. Repaired curbing shall be subject to the approval of the Contracting Officer.

-- End of Section --

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Latest change indicated by CGH tags

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SECTION 02742

BITUMINOUS BINDER AND WEARING COURSES (CENTRAL-PLANT COLD-MIX)
07/97

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NOTE: This guide specification covers the requirements for central-plant cold-mix bituminous binder and wearing courses. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 20	(1970) Penetration Graded Asphalt Cement
AASHTO M 81	(1992) Cut-Back Asphalt (Rapid-Curing Type)
AASHTO M 226	(1980) Viscosity Graded Asphalt Cement
AASHTO T 40	(1978; R 1983) Sampling Bituminous Materials

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 29	(1991a) Unit Weight and Voids in Aggregate
ASTM C 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 117	(1995) Materials Finer than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Course Aggregate
ASTM C 128	(1993) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 183	(1995) Sampling and the Amount of Testing of Hydraulic Cement
ASTM C 206	(1984; R 1992) Finishing Hydrated Lime
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 242	(1995) Mineral Filler for Bituminous Paving Mixtures
ASTM D 490	(1992) Road Tar
ASTM D 633	(1987; R 1991) Volume Correction Table for Road Tar
ASTM D 946	(1982; R 1993) Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 977	(1991) Emulsified Asphalt
ASTM D 1250	(1980; R 1990) Petroleum Measurement Tables
ASTM D 2028	(1976; R 1992) Cutback Asphalt

	(Rapid-Curing Type)
ASTM D 2172	(1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 3381	(1992) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 4791	(1995) Flat or Elongated Particles in Coarse Aggregate

1.2 UNIT PRICES

1.2.1 Measurement

****
NOTE: This paragraphs will be deleted if the work covered by this section is included in one lump sum contract price for the entire work covered by the invitation for bids.
****

The amount paid for will be the number of 2,000 pound tons of bituminous mixture called for in the bid schedule and used in the accepted work. Bituminous-treated material shall be weighed after mixing, and no deduction shall be made for the weight of bituminous material in the mixture.

1.2.1.1 Correctional Factor for Aggregates Used

The quantities of bituminous mixtures called for in the bid schedule are based on aggregates having an apparent specific gravity of 2.65 as determined in accordance with ASTM C 127 and ASTM C 128. A correction in the tonnage of bituminous mixtures shall be made to compensate for the difference in square yards of completed pavement obtained from the tonnage of mixtures used in the project, when the specific gravities of aggregates used are more than 2.70 or less than 2.60. The tonnage paid for shall be number of tonsused, proportionately corrected for specific gravities using 2.65 as base correctional factor.

1.2.1.2 Bituminous Material Unit

****
NOTE: The method of measurement not applicable to job conditions will be deleted.
****

The bituminous material to be paid for will be measured in the number of [gallons of the material used in the accepted work, corrected to gallons at 60 degrees F in accordance with [ASTM D 633] [ASTM D 1250]. A coefficient of 0.00025 per degree F shall be used for asphalt emulsion.] [2000 pound tons of the material used in the accepted work.]

1.2.2 Payment

****
NOTE: This paragraphs will be deleted if the work covered by this section is included in one lump sum contract price for the entire work covered by the

invitation for bids.
****

Bituminous binder and wearing course constructed and accepted will be paid for at the applicable contract unit prices in the unit schedule. No payment will be made for any material wasted, used for the convenience of the Contractor, unused, or rejected.

1.3 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Job Mix Formula (JMF); [_____]. Aggregates; [_____]. Bituminous Materials; [_____].

The job mix formula, at least [_____] days before it is to be used. Notification on the selection of aggregate source. Notification on the selection of bituminous materials source.

SD-09 Reports

Tests; [_____].

Certified copies of aggregate test results, not less than [30] [_____] days before the material is required in the work.

SD-13 Certificates

Bituminous Material; [_____].

Certified copies of the bituminous material manufacturer's test reports indicating compliance with applicable specified requirements, not less than [30] [_____] days before the material is required in the work.

SD-18 Records

Waybills and Delivery Tickets; [_____].

Copies of waybills or delivery tickets, during the progress of the work.

1.4 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.4.1 Mineral Aggregates

Mineral aggregates shall be delivered to the site and stockpiled in such a manner to preclude fracturing of aggregate particles, segregation, contamination or intermingling of different materials in the stockpiles or cold feed hoppers. Before stockpiling material, the storage areas should be cleared, drained and leveled. Mineral filler shall be delivered and stored in a manner to preclude exposure to moisture or other detrimental conditions.

1.4.2 Bituminous Materials

Bituminous materials shall be maintained at appropriate temperature during storage but shall not be heated by application of direct flame to walls of storage tanks or transfer lines. Storage tanks, transfer lines, and weigh bucket shall be thoroughly cleaned before a different type or grade of bitumen is introduced into the system. The asphalt cement shall be heated sufficiently to allow satisfactory pumping of the material; however, the storage temperature shall be maintained below 300 degrees F.

1.5 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.5.1 General Requirements

****

NOTE: The type and capacity of the plant, the number and size of trucks, paving machines, and other equipment should be determined from the tons of paving mixtures required, haul distances, number of working days permitted by the contract, and other pertinent factors.

****

All plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. The equipment shall be adequate for placing the bituminous mixtures at a rate equal to the plant output. The equipment shall be capable of producing the required compaction, meeting grade controls, thickness control and smoothness requirements as set forth herein.

1.5.2 Mixing Plant

The mixing plant shall be an automatic or semi-automatic controlled, commercially manufactured unit designed and operated to consistently produce a mixture within the job-mix formula (JMF). The plant shall have a minimum capacity of [_____] tons per hour.

1.5.3 Rollers

Rollers shall be self-propelled, weigh not less than 10 tons and have a maximum contact pressure of 90 psi.Wheels on the roller shall be equipped with adjustable scrapers and water sprinkling apparatus to keep the wheels wet to prevent the adherence of bituminous material. A sufficient number of rollers shall be used on the work so that one roller will be in continuous operation for 1 hour on each 100 square yards of completed pavement, operating at a speed of not more than 3 mph.

1.5.4   Power Brooms and Power Blowers

Brooms and blowers shall be suitable for cleaning surfaces of the bases and the bituminous course.

1.5.5   Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one [10] [12] footstraightedge for each bituminous paver for use in testing the finished surface. Straightedges shall be constructed of aluminum or other approved lightweight metal and shall have blades of box girder cross section with flat bottom, reinforced to insure rigidity and accuracy. Straightedges shall be equipped with handles for operation on pavement.

1.6   WEATHER LIMITATIONS

Bituminous courses shall be constructed only when the base course or existing pavement is dry and when the weather is not foggy or rainy. Unless otherwise directed, such courses shall not be constructed when the atmospheric temperature is below 60 degrees F.

1.7   SAFETY PRECAUTIONS

[No smoking or open flames will be permitted within 25 feet of heating, distributing or transferring operations of bituminous materials other than bituminous emulsions.] [When tar is used, a full-face, organic, vapor-type respirator and protective creams shall be used by personnel exposed to fumes. Protective creams shall not substitute for cover clothing.]

1.8   WAYBILLS AND DELIVERY TICKETS

****

NOTE: This paragraph will be deleted if the work covered by this section is included in one lump sum contract price for the entire work covered by the invitation for bids.

****

Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed, waybills or certified delivery tickets shall be furnished for all bituminous materials and paving mixtures used in the construction. The Contractor shall not remove bituminous material from the tank car or storage tank until the initial outage has been taken; nor shall the car or tank be released until final outage has been taken.

PART 2   PRODUCTS

2.1   MATERIALS

2.1.1   Bituminous Material

****

NOTE: Only the desired type and grade of bituminous material and the appropriate ASTM specification should be retained. The grade of bituminous material should be selected based on the information

contained in TM-5-822-8.
****

The bituminous material shall conform to [AASHTO M 20] [AASHTO M 81] [AASHTO M 226] or [ASTM D 490] [ASTM D 946] [ASTM D 977] [ASTM D 2028] [ASTM D 3381], Grade [_____].

2.1.2 Aggregates

****

NOTE: The desired gradation to be used for the project should be retained in the project specifications; the other gradation should be omitted. The gradation used in the JMF must meet the requirements of the specifications.

****

Aggregates shall consist of crushed stone, crushed slag, crushed gravel, screenings, sand, and mineral filler. The portion of these materials retained on the No. 8 sieve shall be known as coarse aggregate; the portion passing the No. 8 sieve and retained on the No. 200 sieve, as fine aggregate; and the portion passing the No. 200 sieve, as mineral filler. The aggregate when blended shall conform to the gradation shown in TABLE I when tested in accordance with ASTM C 117 and ASTM C 136.

2.1.2.1 Coarse Aggregates

Coarse aggregates shall consist of clean, sound, durable particles meeting the following requirements:

a. Percentage of loss shall not exceed 40 after 500 revolutions as determined in accordance with ASTM C 131.

****

NOTE: The magnesium-sulfate soundness test is to be used in excluding aggregates known to be unsatisfactory or for evaluating aggregates from new sources. The maximum allowable percentage of loss, usually in the range of 10 to 15 percent, will be inserted in the blanks. The values inserted will be based on knowledge of aggregates in the area that have been previously approved or that have a satisfactory service record in bituminous pavement construction for at least 5 years and will assure that aggregates from new sources will be equal to or better than these aggregates.

****

b. Percentage of loss shall not exceed [_____] after five cycles performed in accordance with ASTM C 88 using magnesium sulfate.

c. The dry weight of crushed slag shall not be less than 75 pcf, as determined in accordance with ASTM C 29.

d. Crushed aggregate retained on the No. 4 sieve and each coarser sieve shall contain at least 75 percent by weight of crushed pieces having one or more fractured faces with an area of each face equal to at least 75 percent of the smallest midsectional area of the piece. When two fractures are contiguous, the angle between planes or fractures shall be at least 30 degrees to count as two fractured faces.

e. Particle shape of crushed aggregates shall be essentially cubical. The quantity of flat and elongated particles in any sieve size shall not exceed 20 percent by weight when determined in accordance with ASTM D 4791.

2.1.2.2   Fine Aggregate

Fine aggregate shall consist of clean, sound, durable particles of natural sand, crushed stone, slag or gravel that meets the requirements for abrasion resistance and soundness specified for coarse aggregate. Fine aggregate produced by crushing gravel shall have at least 90 percent by weight of crushed particles having two or more fractured faces in the portion retained on the No. 30 sieve.

2.1.2.3   Mineral Filler

Mineral filler shall conform to ASTM D 242.

2.1.3   Hydrated Lime

Hydrated lime shall conform to ASTM C 206.

2.1.4   Liquefiers

The use of liquefiers as anti-stripping agent is subject to prior approval by the Contracting Officer.

2.2   JOB MIX FORMULA (JMF)

****

NOTE: The procedure for the design mixture given in TM 5-822-8 should be used to determine the JMF.

****

No bituminous mixture shall be produced until a JMF has been determined by the Contractor and approved by the Contracting Officer. The formula will indicate the definite percentage of each sieve fraction of aggregate, the percentage of bituminous material and the temperature of the completed mixture as discharged from the mixer. The JMF will be allowed the tolerances given in TABLE II. Aggregate gradation and bitumen content may be adjusted, as directed, within the limits specified to improve paving mixtures.

2.3   SAMPLING AND TESTING

2.3.1   General Requirements

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing shall be permitted until the facilities have been inspected and approved. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Tests shall be performed in sufficient numbers and at the locations and times directed to ensure that materials and compaction meet specified requirements. Copies of the test results shall be furnished to the Contracting Officer within 24 hours of the completion of the tests.

2.3.2 Samples

Sampling shall be in accordance with ASTM D 75 for aggregates, ASTM C 183 for mineral filler, and AASHTO T 40 or ASTM D 140 for bituminous material.

2.3.3 Initial Sampling and Testing

2.3.3.1 Source of Aggregates

Sources from which aggregates are to be obtained shall be selected and notification thereof furnished the Contracting Officer within 15 days of the award of the contract. Tests for the evaluation of aggregates shall be made by an approved commercial laboratory at no expense to the Government. Tests for determining the suitability of aggregate shall include, but not limited to: gradation in accordance with ASTM C 136, abrasion resistance in accordance with ASTM C 131, and soundness in accordance with ASTM C 88.

2.3.3.2 Source of Bituminous Materials

Sources from which bituminous materials are to be obtained shall be selected and notification thereof furnished the Contracting Officer within 15 days after the award of the contract.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

3.1.1 Base Course

The surface of the base course shall be cleaned of loose and foreign material. Ruts or soft yielding spots, areas having inadequate compaction, and deviations of surface from requirements specified for the base course shall be corrected by loosening affected areas, removing unsatisfactory material, adding approved material where required, reshaping, and recompacting to line and grade to specified density requirements. The surface shall be sprayed with bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS.

3.1.2 Existing Pavement

The existing pavement shall be cleaned of loose and foreign matter. Cracks 1/4 inch in width and larger shall be cleaned and filled with crack filler material. Deteriorated areas of the pavement shall be repaired as directed. The surface shall be sprayed with a thin coat of bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS.

3.2 GRADE CONTROL

The finished and completed surface course shall conform to the lines, grades, cross sections, and dimensions as indicated. Line and grade stakes shall be placed by the Contractor at the site of the work, in accordance with the SPECIAL CONTRACT REQUIREMENTS, to maintain indicated lines and grades.

3.3 MIXING

3.3.1 Preparation of Mineral Aggregates

Each component of various sizes of aggregates blended in preparing bituminous mixtures shall be placed in separate stockpiles in such manner that separate sizes will not be intermixed. Aggregate shall be fed into the cold elevator by means of separate mechanical feeders to produce a total aggregate graded within requirements specified.

3.3.2 Preparation of Bituminous Mixtures

****

NOTE: If asphalt emulsion is specified the statement in brackets pertaining to moisture content is not applicable and should be deleted.

The appropriate mixing temperatures for the bituminous material and aggregate are found in TABLE III-4 and Paragraph 9.4, Appendix III, respectively, in TM 5-822-8.

****

Aggregates shall be measured and conveyed into the mixer in proportionate quantities of each aggregate size required to meet the JMF. [The moisture content of the finished mixture shall not exceed 2 percent by weight.] Materials shall be introduced into the mixer in the following order: aggregate, [lime,] [flux oil,] [liquefier,] and bituminous material, unless otherwise directed. The temperature of the bituminous material shall be [_____] at the time of mixing. The temperature of the aggregate and mineral filler in the mixer shall not exceed [_____] when the bituminous material is added. If slag aggregate is used, the liquefier shall be sprayed over slag after coating with asphalt cement. [The percentage of hydrated lime used in the mix shall range from 0.5 to 1.5 percent by weight, as directed.] Aggregates and other ingredients shall be mixed for 35 seconds or longer, as necessary, to coat thoroughly all particles with bituminous material. The finished mixture shall not vary from the approved JMF without prior approval of the Contracting Officer.

3.4 TRANSPORTATION OF BITUMINOUS MIXTURES

Mixtures shall be transported to the site in trucks having tight, clean, smooth bodies. Deliveries shall be scheduled so that the spreading and rolling of all mixtures delivered to the site can be completed during daylight unless approved artificial light is provided.

3.5 PLACEMENT

3.5.1 Thickness of Layer

The mixture shall be spread in a layer not greater than 2 inches in thickness. Each layer shall be allowed to cure at least 12 hours or longer if required to achieve proper curing before placing a succeeding layer.

3.5.2 General Requirements for Use of Motor Grader

When approved motor graders are used for spreading the mixture, the material shall be placed on the roadbed in a windrow so that the proper amount of material is available to cover a predetermined width to the indicated compacted thickness. The motor grader may be used to aerate the mixture by working it back and forth across the roadbed in order to get the mixture to the proper condition for compaction.

3.5.3 General Requirements for Use of Mechanical Spreader

When mechanical spreaders are used, the bituminous mixture shall be dumped into an approved mechanical spreader and placed as nearly continuous as possible. The speed of placing shall be adjusted to permit proper rolling.

3.5.4 Offsetting Joints Between Succeeding Courses

Placing of a succeeding course shall be done in such a manner that the longitudinal joints of the succeeding course will not coincide with joints of the previous course and will be offset from joints in the previous course by at least 1 foot. Transverse joints in the succeeding course shall be offset by at least 2 feet from transverse joints in the previous course.

3.5.5 Special Requirements for Laying Strips Succeeding Initial Strip

In laying each succeeding strip after the initial strip has been spread and compacted as specified, the blade of the motor grader or the screed of the mechanical spreader shall overlap previously placed strip 3 to 4 inches at a height required for compaction to produce a smooth, dense joint.

3.5.6 Shoveling, Raking, and Tamping After Machine Spreading

Shovelers and rakers shall follow the spreading machine, raking, removing, and adding mixture as required to obtain a course that, when completed, will conform to all specified requirements. Excessive handwork and broadcasting or fanning of mixture will not be permitted.

3.5.7 Hand Spreading in Lieu of Machine Spreading

In areas where the use of machine spreading is impractical, the mixture shall be spread by hand. Spreading shall be in a manner to prevent segregation. Mixture shall be spread uniformly in a loose layer of thickness that, when rolled, will conform to required thickness.

3.6 COMPACTION

****

NOTE: Consult CEMP-ET on test method to be used and indicate below.

****

[Compaction shall begin immediately after placement.] [The mixture shall be allowed an adequate amount of time for aeration and curing. After curing, the mixture shall be shaped approximately to the specified lines and grades and thoroughly loosened to its full depth and width. Rolling shall begin as soon after placing as the mixture will bear the roller without undue displacement.] Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. The speed of the roller shall be such that displacement of the material does not occur. The density of the compacted mixture shall be at least 96 percent of that of laboratory specimens of the same mixture subjected to 50 blows of the standard

Marshall hammer according to the test procedure in [_____].

3.7 EDGES OF PAVEMENT

The edges of the pavement shall be compacted to the required density and shall be straight and true to required lines. Approved material shall be placed along the edges of the pavement in such quantity as will compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple-layer course, allowing at least a 1 footwidth of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the pavement as directed.

3.8 FINISHING

The surface of the top layer shall be finished to grade and cross section shown. Finished surface shall be uniform texture. Light blading during rolling may be necessary for the finished surface to conform to the lines, grades, and cross sections. Should the surface for any reason become rough, corrugated, uneven in texture, or traffic-marked prior to completion, such unsatisfactory portion shall be scarified, reworked, relaid, or replaced as directed. Should any portion of the course, when laid, become watersoaked for any reason, that portion shall be removed immediately, and the mix placed in a windrow, aerated, and then spread, shaped, and rolled as specified.

3.9 THICKNESS REQUIREMENTS

The compacted thickness of the pavement shall be within 1/2 inch of the thickness indicated. Where measured thickness of the pavement is more than 1/2 inch deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness of the pavement is more than 1/2 inchthicker than indicated, the pavement shall be considered as conforming to the specified thickness requirements.

3.10 SURFACE-SMOOTHNESS REQUIREMENTS

3.10.1 Intermediate Courses

The surface of each intermediate course shall be checked longitudinally with a [10] [12] footstraightedge and checked transversely with a template conforming to the specified cross section. The surface of the layer, after rolling shall not deviate more than 1/4 inch from the [10] [12] foot straightedge nor 1/4 inch from the template. Any irregularities shall be corrected by loosening and reshaping the aggregate, removing or adding aggregate as required, and rerolling such areas.

3.10.2 Finished Surfaces

3.10.2.1 Roads and Streets

The surface of the finished pavement shall be checked longitudinally with a [10] [12] foot straightedge and transversely with a template cut to the specified cross section. The finished surface of the surface course shall not deviate more than 1/8 inch from the [10] [12] foot straightedge or from the template. Surface irregularities exceeding those specified shall be corrected [as specified] [as directed].

3.10.2.2 Other Than Roads and Streets

The surface of the finished pavement shall be checked longitudinally and transversely with a [10] [12] foot straightedge. The finished surface of the finished pavement shall not deviate more than 1/4 inch from the [10] [12] foot straightedge. Surface irregularities exceeding tolerances specified shall be corrected [as specified] [as directed].

3.11 JOINTS

Joints shall present the same texture, density, and smoothness as other sections of the course. Joints between old and new pavements or between successive days' work shall be made carefully to insure continuous bond between old and new sections of the course. Contact surfaces of previously constructed pavements shall be painted with a thin, uniform coat of bituminous material, conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS, just before the fresh mixture is placed.

3.11.1 Transverse Joints

The roller shall pass over the unprotected end of the freshly laid mixture only when the laying of the course is discontinued. The edge of the previously laid course shall be cut back to expose an even, vertical surface for the full thickness of the course. The fresh mixture shall be raked against the joints, thoroughly tamped, and then rolled.

3.11.2 Longitudinal Joints

When the edges of the longitudinal joints are irregular, honeycombed, or poorly compacted, all unsatisfactory sections of the joint shall be cut back to expose an even, vertical surface for the full thickness of the course. Where required, fresh mixture shall be raked against the joint, thoroughly tamped, and then rolled.

3.12 FIELD QUALITY CONTROL AND TESTING

****

NOTE: The appropriate frequency interval of testing should be inserted in the blanks.

****

3.12.1 Testing

Field tests shall be performed in sufficient numbers to assure that the specifications are being met. Testing shall be the responsibility of the Contractor and shall be performed by an approved commercial laboratory. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type of operation.

3.12.1.1 Field Density

****

NOTE: Consult CEMP-ET on test method to be used and indicate below.

****

The field density shall be expressed as a percentage of the laboratory density. Laboratory samples shall be prepared from an uncompacted mixture taken from the pavement immediately prior to field compaction and the samples shall be compacted in accordance with [_____]. The asphalt mixture shall not be reheated in the laboratory. A minimum of one field density test shall be performed for every [_____] tons of mixture placed.

3.12.1.2 Gradation

A minimum of one gradation shall be performed for every [_____] ton of aggregate used in the mixture, with a minimum of three gradations for each day's run. When the source of materials is changed or deficiencies are found, the gradation shall be replaced and the material already placed shall be retested to determine the extent of the unacceptable material. All in-place unacceptable material shall be replaced at no additional expense to the Government.

3.12.1.3 Abrasion Resistance

Abrasion resistance tests shall be performed in accordance with ASTM C 131 to ensure that the aggregates have a percentage of wear not exceeding 40 percent after 500 revolutions. One test shall be performed for every [_____] ton of aggregate placed.

3.12.1.4 Soundness Test

****

NOTE: The magnesium-sulfate soundness test is to be used in excluding aggregates known to be unsatisfactory or for evaluating aggregates from new sources. The maximum allowable percentage of loss, usually in the range of 10 to 15 percent, will be inserted in the blanks. The values inserted will be based on knowledge of aggregates in the area that have been previously approved or that have a satisfactory service record in bituminous pavement construction for at least 5 years and will assure that aggregates from new sources will be equal to or better than these aggregates.

****

Soundness tests shall be performed as specified by ASTM C 88 to insure that the aggregates have a weight loss not greater than [_____] percent when subjected to five cycles of the magnesium sulfate test. One test shall be performed for every [_____] tons of aggregate placed.

3.12.1.5 Smoothness

Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline, with a [10] [12] foot straightedge. The surface of each course shall be checked transversely with [a template cut to the specified cross section] [a [10] [12] foot straightedge] placed perpendicular to the road centerline at [_____] foot intervals.

3.12.1.6 Thickness

The thickness of the pavement shall be determined every [_____] feet along the finished surface. Measurements shall be made in 3 inch diameter test holes penetrating the pavement. The holes shall be refilled to conform to these specifications.

3.12.1.7 Bitumen Content

Samples of finished plant mixture shall be taken and tested for each [_____] tons or fraction thereof, to determine if bitumen content is in accordance with ASTM D 2172 and conforms to the specified requirements.

3.12.2 Bituminous Material Sample

A sample of the bituminous material used will be obtained by the Contractor under the supervision of the Contracting Officer. The sample will be retained by the Government.

3.13 PROTECTION OF PAVEMENT

The pavement shall be maintained in a satisfactory condition until accepted by the Contracting Officer.

3.14 SCHEDULES

TABLE I. AGGREGATE GRADATIONS FOR PLANT-MIXED COLD-LAID BITUMINOUS PAVEMENTS

	Percent by Weight Passing Square-Mesh Sieve	
Sieve Size	No. 1	No. 2
1/2 inch	100	---
3/8 inch	77-95	100
No. 4	57-75	76-94
No. 8	44-62	62-80
No. 16	32-50	48-66
No. 30	22-40	34-52
No. 50	13-29	23-39
No. 100	7-19	13-25
No. 200	3-6	3-9

TABLE II. JOB-MIX TOLERANCES

Material	Tolerance, Plus or Minus
Aggregate passing No. 4 sieve or larger	5 percent
Aggregate passing Nos. 8, 16, 30, and 50 sieves	4 percent
Aggregate passing No. 200 sieve	1.5 percent
Bitumen	0.25 percent
[Liquefier	0.20 percent]
Temperature	25 degrees F

-- End of Section --

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DEPARTMENT OF THE ARMY **HED-02748 (February 2000)**
U.S. ARMY CORPS OF ENGINEERS **-------------------------**
Superseding
HED-02748 (April 1999)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

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02/00

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02748

BITUMINOUS TACK AND PRIME COATS
02/00

****
NOTE: This guide specification covers the requirements for bituminous tack and prime coats for airfield pavements, roads, parking areas and general paving needs. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-700.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

ASTM D 140 (1993) Sampling Bituminous Materials

ASTM D 946	(1982; R 1993) Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 977	(1991) Emulsified Asphalt
ASTM D 1250	(1980; R 1990) Petroleum Measurement Tables
ASTM D 2027	(1976; R 1992) Cutback Asphalt (Medium-Curing Type)
ASTM D 2995	(1993) Determining Application Rate of Bituminous Distributors
ASTM D 3381	(1992) Viscosity-Graded Asphalt Cement for Use in Pavement Construction

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 40	(1978; R 1983) Sampling Bituminous

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-09 Reports

Tests; FIO.

Copies of all test results for bituminous materials, within 24 hours of completion of tests. Certified copies of the manufacturer's test reports indicating compliance with applicable specified requirements, not less than 30 days before the material is required in the work.

SD-18 Records

Waybills and Delivery Tickets; FIO.

Waybills and delivery tickets, during progress of the work.

1.3   PLANT, EQUIPMENT, MACHINES AND TOOLS

1.3.1   General Requirements

Plant, equipment, machines and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times.

1.3.2   Bituminous Distributor

The distributor shall have pneumatic tires of such size and number to prevent rutting, shoving or otherwise damaging the base surface or other layers in the pavement structure. The distributor shall be designed and equipped to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled rates with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. The distributor shall be equipped to circulate and agitate the bituminous material during the heating process.

1.3.3   Power Brooms and Power Blowers

Power brooms and power blowers shall be suitable for cleaning the surfaces to which the bituminous coat is to be applied.

1.4   WEATHER LIMITATIONS

Bituminous coat shall be applied only when the surface to receive the bituminous coat is dry.

PART 2   PRODUCTS

2.1   TACK COAT

****

NOTE: The following information should be reviewed before making the selection of bituminous material:

a. If ASTM D 2028 or AASHTO M 81 is used, then Note A of TABLE 1 of ASTM D 2028 or AASHTO M 82 should be reviewed and the material specified by viscosity or penetration. Cutback asphalt grades recommended for tack are RC-70 and RC-250; they may be used generally as a tack in pavement construction. In cold-weather construction, they can be used with less concern than emulsions which contain water.

b. Paving grade asphalts can also be used in tack applications. More heat is required to achieve spraying consistency for these materials. Selection of a grade involves consideration of the various grading systems used. The following materials are recommended:

Penetration Grades (ASTM D 946 or AASHTO M 20)

200-300
120-150
85-100

Viscosity Grades (ASTM D 3381 or AASHTO M 226, TABLE 1 or 2)

AC 2.5
AC 5
AC 10

Aged Residue Viscosity Grades (ASTM D 3381 or AASHTO M 226)

AR 1000
AR 2000
AR 4000

The harder grades, 85-100 penetration, AC 10, and AR 4000 viscosity grades, are recommended for airfields. These grades are harder and would be better able to resist uplift pressures causes by jet engines. The other grades may be considered for more general use. The temperature-viscosity relation for the job asphalt should be checked to ensure that a spraying consistency can be achieved in the recommended temperature range of paragraph APPLICATION TEMPERATURE.

c. Either anionic or cationic emulsions can be used for tack. A list of recommended emulsions is as follows:

Anionic Emulsion ASTM D 977

RS-1
MS-1
HFMS-1
SS-1
SS-1h

Cationic Emulsions ASTM D 2397

CRS-1
CSS-1
CSS-1h

Grades SS-1h and CSS-1h are made with a harder base asphalt and are recommended for airfields. The other grades can be considered for general use. Grades RS-1, SS-1, and SS-1h are widely used tack materials.

d. An asphalt-based tack or tar tack may be used between an asphalt and tar or tar-rubber concrete course, but a tar tack should be used between tar and tar-rubber concrete courses. This specification must be altered for a tar tack coat.
****

Emulsified asphalt shall conform to ASTM D 977 Grade SS-1 or SS-1h.

2.2 PRIME COAT

****
NOTE: Remove brackets from around the material to be allowed in the contract specifications and delete the other materials and references.

a. If cutback asphalts are used, one of the following types and grades can be recommended:

Slow-Curing Type (ASTM D 2026): SC-70, SC-250.
Medium-Curing Type (ASTM D 2027 or AASHTO M 82): MC-30, MC-70, MC-250.
Rapid-Curing Type (ASTM D 2028 or AASHTO M 81): RC-70, RC-250.

Selection of a particular type and grade should consider the nature of the surface to be treated. An open base course material will be penetrated readily, and all of the above types and grades can be considered except for the low viscosity MC-30. A tight surface is not going to be penetrated as readily; therefore, the less viscous materials are recommended such as RC-70, MC-30, MC-70 and SC-70. Some caution might be urged in using RC-70 or RC-250 because the solvent may separate or be absorbed by the base course fines and leave the asphalt deposited on the surface. Cutback asphalts can be used in cold-weather construction with less concern than emulsions which contain water. Less viscous grades may be used for cold-weather construction such as RC-70, MC-30 and MC-70.

b. There are two types of emulsions that can be used for prime coats. A list of recommended emulsion grades by type is as follows:

Anionic Emulsions ASTM D 977: SS-1, SS-1h.
Cationic Emulsions ASTM D 2397: CSS-1, CSS-1h.

Penetration and coating will be most efficient at about optimum moisture content. Water dilution of the emulsion is also required to reduce viscosity.
****

Cutback asphalt shall conform to ASTM D 2027, Grade MC-30 or MC-70.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

****
NOTE: If the surface to be treated requires repairs, the method of repairs and extent of work involved should be shown or described.
****

Immediately before applying the bituminous coat, all loose material, dirt, clay, or other objectionable material shall be removed from the surface to be treated. The surface shall be dry and clean at the time of treatment.

3.2 APPLICATION RATE

****
NOTE: The range of application rates for the bituminous materials is for the bituminous residue content and does not include water or solvents that are contained in emulsified or liquid bituminous materials. The use of liquid or emulsified material requires that the application rates be corrected. Any prescribed application should be corrected and divided into two applications 24 hours apart when necessary to avoid flowing off the surface because of grade or slope.
****

The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the Contracting Officer.

3.2.1 Tack Coat

Bituminous material for the tack coat shall be applied in quantities of not less than 0.05 gallon nor more than 0.15 gallon per square yard of pavement surface.

3.2.2 Prime Coat

Bituminous material for the prime coat shall be applied in quantities of not less than 0.15 gallon nor more than 0.40 gallon per square yard of pavement surface.

3.3 APPLICATION TEMPERATURE

3.3.1 Viscosity Relationship

Asphalt application temperature shall provide an application viscosity between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 centistokes, kinematic. The temperature viscosity relation shall be furnished to the Contracting Officer.

3.3.2 Temperature Ranges

****
NOTE: Normal spray application temperatures are as

follows. Edit and coordinate materials with Part 2 PRODUCTS. Remove brackets from the material to be allowed in the specification and delete the other materials in brackets.
****

The viscosity requirements shall determine the application temperature to be used. The following is a normal range of application temperatures:

Liquid Asphalts	
[MC-30	85-190 degrees F]
[MC-70	120-225 degrees F]

Emulsions	
[SS-1	70-160 degrees F]
[SS-1h	70-160 degrees F]

*These temperature ranges exceed the flash point of the material and care should be taken in their heating.

3.4 APPLICATION

****
NOTE: Retain the last bracketed sentences in this paragraph if prime coat is specified.
****

Following preparation and subsequent inspection of the surface, the bituminous coat shall be applied at the specified rate with uniform distribution over the surface to be treated. All areas and spots missed by the distributor shall be properly treated with the hand spray. Until the succeeding layer of pavement is placed, the surface shall be maintained by protecting the surface against damage and by repairing deficient areas at no additional cost to the Government. If required, clean dry sand shall be spread to effectively blot up any excess bituminous material. No smoking, fires, or flames other than those from the heaters that are a part of the equipment shall be permitted within 25 feet of heating, distributing, and transferring operations of bituminous material other than bituminous emulsions. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent applications, building paper shall be spread on the surface for a sufficient distance back from the ends of each application to start and stop the prime coat on the paper. Immediately after application, the building paper shall be removed and destroyed.

3.5 CURING PERIOD

****
NOTE: Retain bracketed sentence if prime coat is specified.
****

Following application of the bituminous material and prior to application of the succeeding layer of pavement, the bituminous coat shall be allowed to cure and to obtain evaporation of any volatiles or moisture. Prime coat shall be allowed to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course.

3.6 FIELD QUALITY CONTROL

****
NOTE: Select the appropriate paragraph based on the amount of bituminous material required.
****

Two samples of the bituminous material shall be tested for compliance with the applicable specified requirements. A sample shall be obtained and tested by the Contractor.

3.7 SAMPLING AND TESTING

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved.

3.7.1 Sampling

The samples of bituminous material, unless otherwise specified, shall be in accordance with ASTM D 140 or AASHTO T 40. Sources from which bituminous materials are to be obtained shall be selected and notification furnished the Contracting Officer within 15 days after the award of the contract.

3.7.2 Calibration Test

The Contractor shall furnish all equipment, materials, and labor necessary to calibrate the bituminous distributor. Calibration shall be made with the approved job material and prior to applying the bituminous coat material to the prepared surface. Calibration of the bituminous distributor shall be in accordance with ASTM D 2995.

3.7.3 Trial Applications

Before providing the complete bituminous coat, three lengths of at least 100 feet for the full width of the distributor bar shall be applied to evaluate the amount of bituminous material that can be satisfactorily applied.

3.7.3.1 Tack Coat Trial Application Rate

Unless otherwise authorized, the trial application rate of bituminous tack coat materials shall be applied in the amount of 0.05 gallons per square yard. Other trial applications shall be made using various amounts of material as may be deemed necessary.

3.7.3.2 Prime Coat Trial Application Rate

Unless otherwise authorized, the trial application rate of bituminous materials shall be applied in the amount of 0.25 gallon per square yard. Other trial applications shall be made using various amounts of material as may be deemed necessary.

3.7.4 Sampling and Testing During Construction

Quality control sampling and testing shall be performed as required in paragraph FIELD QUALITY CONTROL.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02753 (March 1997)**
U.S. ARMY CORPS OF ENGINEERS **-----------------------**
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SECTION 02753

CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER HEAVY-DUTY PAVEMENTS
03/97

****
NOTE: This guide specification covers the requirements for construction of concrete pavement for rigid pavement for airfields and heavy-duty roads and hardstands, and vehicular pavement greater than 2000 cubic meters (2500 cu. yd.). This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: In preparing contract specifications for concrete pavement, the designer will use TM 5-822-7 STANDARD PRACTICE FOR CONCRETE PAVEMENTS for guidance. State highway specifications may only be used for nonorganizational parking, roads, streets, and driveways where the paving index is less than 5. All organizational vehicle parking, roads and airfield concrete pavements will use Corps of

Engineers guide specifications without exception.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214.3R	(1988) Simplified Version of the Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 305R	(1991) Hot Weather Concreting

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(1991) Burlap Cloth Made from Jute or Kenaf

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1997) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 184/A 184M	(1996) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 185	(1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 497	(1997) Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A 615/A 615M	(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616/A 616M	(1996a) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617/A 617M	(1996a) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM C 29/C 29M	(1997)Bulk Density ("Unit Weight)" and Voids in Aggregate

ASTM C 31/C 31M	(1996) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1997) Concrete Aggregates
ASTM C 39	(1996) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 78	(1994) Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C 94	(1997) Ready-Mixed Concrete
ASTM C 117	(1995) Materials Finer Than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 123	(1996) Lightweight Pieces in Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 142	(1978; R 1990) Clay Lumps and Friable Particles in Aggregates
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 150	(1997) Portland Cement
ASTM C 171	(1997) Sheet Materials for Curing Concrete
ASTM C 172	(1997) Sampling Freshly Mixed Concrete
ASTM C 174/C 174M	(1997) Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C 192/C 192M	(1995) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1995) Air-Entraining Admixtures for Concrete
ASTM C 295	(1990) Petrographic Examination of Aggregates for Concrete
ASTM C 330	(1989) Lightweight Aggregates for Structural Concrete
ASTM C 470	(1994) Molds for Forming Concrete Test Cylinders Vertically

ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 595	(1995a) Blended Hydraulic Cements
ASTM C 618	(1997) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 881	(1990) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 989	(1997) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1064	(1986; R 1993) Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1077	(1997) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1240	(1997) Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar and Grout
ASTM D 449	(1989; R 1994) Asphalt Used for Dampproofing and Waterproofing
ASTM D 946	(1982; R 1993) Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 1227	(1995) Emulsified Asphalt Used as a Protective Coating for Roofing
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1983; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 3665	(1994) Random Sampling of Construction Materials

CALIFORNIA DEPARTMENT OF TRANSPORTATION (CDT)

CDT Test 526	(1978) Operation of California Profilograph and Evaluation of Profiles

ARMY CORPS OF ENGINEERS (COE)

COE CRD-C 55	(1992) Test Method for Within-Batch Uniformity of Freshly Mixed Concrete
COE CRD-C 100	(1975) Method of Sampling Concrete

	Aggregate and Aggregate Sources, and Selection of Material for Testing
COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 114	(1994) Test Method for Soundness of Aggregates by Freezing and Thawing of Concrete Specimens
COE CRD-C 119	(1991) Standard Test Method for Flat or Elongated Particles in Coarse Aggregate
COE CRD-C 130	(1989) Scratch Hardness of Coarse Aggregates Particles
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 171	(1995) Test Method for Determining Percentage of Crushed Particles in Aggregate
COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing Concrete
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
COE CRD-C 540	(1971; R 1981) Standard Specification for Nonbituminous Inserts for Contraction Joints in Portland Cement Concrete Airfield Pavements, Sawable Type
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop

FEDERAL SPECIFICATIONS (FS)

FS TT-P-645	(Rev B) Primer, Paint, Zinc-Molybdenum, Alkyd Type

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(1997) NIST Handbook 44: Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(1996) Concrete Plant Standards

SSPC: THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 5	(1995) Zinc Dust, Zinc Oxide, and Phenolic Varnish Paint.
SSPC Paint 25	(1991) Red Iron Ixide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead or Chromate Pigments).

1.2 SYSTEM DESCRIPTION

****

NOTE: Use this section only for airfield pavement and other heavy-duty pavements. Edit this paragraph or delete as appropriate.

****

This section is intended to stand alone for construction of concrete (rigid) pavement. However, where the construction covered herein interfaces with other sections, the construction at each interface shall conform to the requirements of both this section and the other section, including tolerances for both.

1.3 MEASUREMENT AND PAYMENT

****

NOTE: Any project large enough to use this guide specification must have Unit Price payment. Do not use Lump Sum payment.

****

1.3.1 Measurements

1.3.1.1 Concrete

The quantity of concrete to be paid for will be the volume of concrete in cubic yards including monolithic curb, where required, placed in the completed and accepted pavement. Concrete will be measured in place in the completed and accepted pavement only within the neat line dimensions shown in the plan and cross section. No deductions will be made for rounded or beveled edges or the space occupied by pavement reinforcement, dowel bars, tie bars, or electrical conduits, nor for any void, or other structure extending into or through the pavement slab, measuring 3 cubic feet or less in volume. No other allowance for concrete will be made unless placed in specified locations in accordance with written instructions previously issued by the Contracting Officer.

1.3.1.2 Mixture Proportions By Contractor

****

NOTE: Delete this paragraph when the mixture proportions are provided by the Government; renumber paragraphs accordingly.

****

The Contractor shall be responsible for the mixture proportions of cementitious materials and chemical admixtures; no separate measurement or payment will be made for any cementitious material, including pozzolan, or for any chemical admixture.

1.3.1.3   Mixture Proportions By Government

****
NOTE: Delete this paragraph when the mixture proportions are provided by the Contractor; renumber paragraphs accordingly. Delete part c. when no water reducing admixture is permitted.
****

The mixture proportions are the responsibility of the Government. No payment will be made for wasted materials or for any material used for the convenience of the Contractor.

a. General. The quantity of portland cement and [blended cement] [ground granulated blast furnace (GGBF) slag] [silica fume] to be paid for will be the lb. of portland cement [blended cement] [GGBF slag] [and silica fume] used in concrete within the pay lines of the completed and accepted pavement. The quantity of each cementitious material to be paid for will be determined by multiplying the approved batch mass of each material in lb/cu. yd. of concrete required, from the mixture proportions of each material for the various mixtures used, by the number of cu. yd. of concrete measured for payment as specified above for "Concrete".

b. Pozzolan. The quantity of pozzolan to be paid for will be the number of cu. ft. solid volume of pozzolan used in the concrete within the pay lines of the completed and accepted pavement. The quantity to be paid for will be determined by multiplying the approve batch mass, in lb. of pozzolan per cu. yd. of concrete required by the mixture proportions for the various mixtures used, by the number of cu. yd. of concrete measured for payment as specified above for "Concrete", and then dividing by the average solid density of the pozzolan in lb/cu. ft. The average solid density will be the average of the test results for all material accepted during the period covered by the payment. If no pozzolan was accepted during the period, the test results from the last shipment accepted at the project will be used.

c. Chemical Admixtures. The quantity of water reducing admixture (WRA) to be paid for will be based on the number of cu. yd. of concrete in which the WRA is used, measured as specified above for "Concrete". No payment will be made, under any conditions, for air-entraining, accelerating, or retarding admixtures.

1.3.1.4   Steel Reinforcement

Fabricated steel bar mats or welded steel wire fabric for reinforcement will be measured by the yard. The quantity of steel reinforcement paid for will be equal to the actual number of yards of the completed and accepted pavement requiring reinforcement as shown on the drawings or as directed. No additional payment will be made for steel reinforcement used in laps, wasted, or used for the convenience of the Contractor.

1.3.1.5   Dowels and Tie Bars

****
NOTE: Delete "and tie bars" in both the title and

body of the paragraph, if none are used.
****

The quantity of dowels and tie bars used in the work will not be measured for payment but will be considered as a subsidiary obligation of the Contractor, covered under the price per yard for concrete.

1.3.1.6   Joint Materials

The quantity of expansion joint filler, slip joint filler, and inserts for contraction joints will not be measured for payment but will be considered as a subsidiary obligation of the Contractor, covered under the price per yard for concrete. Joint sealing materials are covered in Section 02760 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS or Section 02762 COMPRESSION JOINT SEALS FOR CONCRETE PAVEMENTS.

1.3.2   Payments

1.3.2.1   Concrete

The quantity of concrete measured as specified above will be paid for at the contract unit price when placed in completed and accepted pavements. Payment shall be made at the contract price for yardfor the scheduled item, with necessary adjustments as specified in paragraph ACCEPTABILITY OF WORK AND PAYMENT ADJUSTMENTS. Payment will constitute full compensation for furnishing all materials, equipment, plant and tools, and for all labor and other incidentals necessary to complete the concrete pavement, except for other items specified herein for separate payment.

1.3.2.2   Cementitious Material

****
NOTE: Delete if not needed. Edit brackets for material being used.
****

The quantity of portland cement and [blended cement] [GGBF slag] [pozzolan-fly ash] [pozzolan-silica fume] determined as specified above will be paid for at the appropriate contract unit price, which will include all costs of handling, hauling, and storage.

1.3.2.3   Water-Reducing Admixture

****
NOTE: Delete if not needed.
****

The quantity of WRA determined as specified above will be paid for at the contract unit price per yard of concrete containing WRA, which includes all costs of handling, hauling, and storage at the site.

1.3.2.4   Steel Reinforcement

The quantity of welded steel wire fabric or fabricated steel bar mats measured as specified above will be paid for at the contract unit price per yard of concrete in which it is used, which includes all costs of furnishing and placing in the concrete pavements.

1.4   ACCEPTABILITY OF WORK AND PAYMENT ADJUSTMENTS

****

NOTE: Normally, delete the bracketed first sentence and require Contractor testing as specified here. If Government testing is desired, use the bracketed first sentence and then edit this paragraph and all its subparagraphs accordingly so as to be totally correlated; correlate these paragraphs with all other specification requirements.

****

[Except as otherwise specified, testing for acceptability of work and, where appropriate, payment adjustments will be performed by the Government.] Concrete samples shall be taken by the Contractor in the field to determine the slump, air content, and strength of the concrete. Test beams and test cylinders shall be made for determining conformance with the strength requirements of these specifications [and, when required, for determining the time at which pavements may be placed into service]. Any pavement not meeting the requirement for 'specified strength' shall be removed and replaced at no aditional cost to the Government. The air content shall be determined in accordance with ASTM C 231. Slump tests shall be made in accordance with ASTM C 143. Test beams and cylinders shall be molded and cured in accordance with ASTM C 31/C 31Mand as specified below. Steel molds shall be used for molding the beams specimens. Molds for cylinder test specimens shall conform to ASTM C 470. The Contractor shall furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Laboratory curing facilities for test specimens shall include furnishing and operating water tanks equipped with temperature-control devices that will automatically maintain the temperature of the water at 73 plus or minus 5 degrees F. The Contractor shall furnish and maintain at the site boxes or other facilities suitable for storing the specimens while in the mold at a temperature of 73 plus or minus 10 degrees F. Tests of the fresh concrete and of the hardened concrete specimens shall be made by and at the expense of the Contractor.

1.4.1   Pavement Lots

****

NOTE: The lot size can be specified on the basis of time (i.e., 4 hours, 1 day, etc.) or amount of production (i.e., 375 cubic meters (500 cu. yd.), 750 cubic meters (1000 cu. yd.), etc.). Normally, it is most practical for field people if a lot is made equal to one shift, but not over 10 hours. If the lot size is based on the amount of production, it should be selected to be approximately equal to the amount of concrete pavement produced in one shift (one day) of operation. The lot size should never exceed 750 cubic meters (1000 cu. yd.) of concrete pavement. When the total job does not exceed 375 cubic meters (500 cu. yd.), the lot size becomes the total job. The following paragraphs will be edited accordingly. Do not change terminology (computed percent payment, actual percent payment, etc.).

****

Appropriate adjustment in payment for individual lots of concrete pavement will be made in accordance with the following paragraphs. No such adjustment in payment will be made for any material other than concrete. A lot will be that quantity of construction that will be evaluated for compliance with specification requirements. A lot will be equal to [[_____] tons] [[8] [_____] hour's] production. In order to evaluate thickness, each lot will be divided into four equal sublots. Grade and surface smoothness (and condition) determinations will be made on the lot as a whole. However, any pavement not meeting the required 'specified strength' shall be removed and replaced at no additional cost to the Government. Strength will be evaluated, but will not be considered for payment adjustment. Edge slump requirements will be applied to each individual slab into which the primary paving lanes are divided by transverse joints, and will not be considered for payment adjustment. Samples for determining aggregate grading for fine aggregate and each size of coarse aggregate shall be taken as the aggregate bins discharge into the weigh hoppers. Results of tests on aggregates shall be used to control aggregate production and concreting operations, as specified in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL, but will not be used for payment adjustment. Samples for determining air content and slump and for fabricating strength specimens shall be taken in accordance with ASTM C 172 during or immediately following delivery of the concrete at the paving site and deposition of the concrete immediately in front of the paver or transfer spreader. Results of strength tests shall be used to control concreting operations, but will not be used for payment adjustment. Cores for thickness determination shall be drilled and evaluated as specified. Location of all samples shall be as directed and will be deliberately selected on a truly random basis, not haphazard, using commonly recognized methods of assuring randomness, employing randomizing tables or computer programs, in accordance with ASTM D 3665.

1.4.2 Acceptance of Lots

When a lot of material fails to meet the specification requirements, that lot will be accepted at a reduced price or shall be removed and replaced. The lowest computed percent payment determined for any pavement characteristic (i.e., thickness, grade, and surface smoothness) discussed below shall be the actual percent payment for that lot. The actual percent payment will be applied to the bid price and the quantity of concrete placed in the lot to determine actual payment.

1.4.3 Evaluation

****

NOTE: Add to and edit these items as appropriate, if Government testing is desired.

****

The Contractor shall provide facilities for and, where directed, personnel to assist in obtaining samples for any Government testing, all at no additional cost to the Government. Such testing will in no way relieve the Contractor of any specified testing responsibilities. The Contractor shall provide all sampling and testing required for acceptance and payment adjustment at its expense. Such sampling and testing shall be performed by a commercial testing laboratory inspected by the Government and approved in writing. The laboratory performing the tests shall be on-site and shall conform with ASTM C 1077. The individuals who sample and test concrete or the constituents of concrete as required in this specification shall be certified as American Concrete Institute (ACI) Concrete Field Testing Technicians, Grade I, or shall have otherwise demonstrated to the satisfaction of the Contracting Officer other training providing knowledge and ability equivalent to the ACI minimum requirements for certification. The individuals who perform the inspection of concrete shall be certified as ACI Concrete Construction Inspector, Level II, or have otherwise demonstrated to the satisfaction of the Contracting Officer other training providing knowledge and ability equivalent to the ACI minimum requirements for certification. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C 1077.

1.4.4 Additional Sampling and Testing

The Contracting Officer reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. Testing in these areas will be in addition to the sublot or lot testing, and the requirements for these areas will be the same as those for a sublot or lot, but shall be at no additional cost to the Government.

1.4.5 Air Content Tests

Air content of the concrete shall be controlled as specified in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL and will not be considered for payment adjustment.

1.4.6 Slump Tests

Slump of the concrete shall be controlled as specified in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL and will not be considered for payment adjustment.

1.4.7 Surface Smoothness

****

NOTE: Edit these paragraphs as appropriate to the project. If it is desired to restrict surface smoothness testing and evaluation to either straightedge method or profilograph method, retain the one and delete the other; otherwise, retain both as a Contractor's option. Generally, designer should require use of the profilograph method. If the profilograph method is allowed, and there are areas with dimensions less than 60 m (200 feet) in any direction, part of the straightedge method must be retained for these short runs.

****

The Contractor shall use [one] [both] of the following methods to test and evaluate surface smoothness of the pavement. All testing shall be performed in the presence of the Contracting Officer's representative. Detailed notes shall be kept of the results of the testing and a copy furnished to the Government immediately after each day's testing. The profilograph method shall be used for all longitudinal and transverse testing, except where the runs would be less than 200 feet in length and at the ends where the straightedge shall be used. Where drawings show required deviations from a plane surface (crowns, drainage inlets, etc.), the surface shall be finished to meet the approval of the Contracting Officer.

1.4.7.1 Smoothness Requirements

a. Straightedge Testing: The finished surfaces of the pavements shall have no abrupt change of 1/8 inch or more, and all pavements shall be within the limits specified in Table 1 when checked with an approved 12 foot straightedge.

TABLE 1
STRAIGHTEDGE SURFACE SMOOTHNESS--PAVEMENTS

Pavement Category	Direction of Testing	Limits Inches
Runways and Taxiways	Longitudinal	1/8
	Transverse	1/4
Calibration Hardstands & Compass Swinging Bases	Longitudinal	1/8
	Transverse	1/8
All Other Airfield and Helicopter Paved Areas	Longitudinal	1/4
	Transverse	1/4
Roads and Streets	Longitudinal	3/16
	Transverse	1/4
Tank Hardstands, Parking Areas, Open Storage Areas	Longitudinal	1/4
	Transverse	1/4

b. Profilograph Testing: The finished surfaces of the pavements shall have no abrupt change of 1/8 inch or more, and all pavement shall have a Profile Index not greater than specified in Table 2 when tested with an approved California-type profilograph. If the extent of the pavement in either direction is less than 200 feet, that direction shall be tested by the straightedge method and shall meet requirements specified for such.

TABLE 2
PROFILOGRAPH SURFACE SMOOTHNESS--PAVEMENTS

Pavement Category	Direction of Testing	Maximum Specified Profile Index Inch per mile
Runways	Longitudinal	7
	Transverse	9
Taxiways	Longitudinal	9
	Transverse	(Use Straightedge)
Calibration Hardstands and Compass Swinging Bases		(Use Straightedge)
All Other Airfield and Helicopter Paved Areas	Longitudinal	9
	Transverse	9

TABLE 2
PROFILOGRAPH SURFACE SMOOTHNESS--PAVEMENTS

Pavement Category	Direction of Testing	Maximum Specified Profile Index Inch per mile
Roads and Streets	Longitudinal Transverse	9 (Use Straightedge)
Tank Hardstands, Parking Areas, Open Storage Areas	Longitudinal Transverse	11 11

1.4.7.2 Testing Method

After the concrete has hardened sufficiently to permit walking thereon, but not later than 36 hours after placement, the surface of the pavement in each entire lot shall be tested by the Contractor in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. However, transverse profilograph testing of multiple paving lanes shall be performed at the timing directed. Separate testing of individual sublots is not required. If any pavement areas are ground, these areas shall be retested immediately after grinding. The entire area of the pavement shall be tested in both a longitudinal and a transverse direction on parallel lines. The transverse lines shall be 15 feet or less apart, as directed. The longitudinal lines shall be at the centerline of each paving lane shown on the drawings, regardless of whether the Contractor is allowed to pave two lanes at a time, and at the 1/8th point in from each side of the lane. Other areas having obvious deviations shall also be tested. Longitudinal testing lines shall be continuous across all joints. Transverse testing lines for pilot lanes shall be carried to construction joint lines and for fill-in lanes shall be carried 24 inches across construction joints, and the readings in this area applied to the fill-in lane. Straightedge testing of the longitudinal edges of slipformed pilot lanes shall also be performed before paving fill-in lanes as specified in paragraph "Edge Slump and Joint Face Deformation".

a. Straightedge Testing: The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length and measuring the maximum gap between the straightedge and the pavement surface, in the area between these two high points.

b. Profilograph Testing: Profilograph testing shall be performed using approved equipment and procedures described in CDT Test 526. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for the pavement. The "blanking band" shall be 0.2 inches wide and the "bump template" shall span 1 inch with an offset of 0.4 inch. The profilograph shall be operated by an approved, factory-trained operator on the alignments specified above. A copy of the reduced tapes shall be furnished the Government at the end of each day's testing.

1.4.7.3 Payment Adjustment for Smoothness

a. Straightedge Testing: Location and deviation from straightedge for all measurements shall be recorded. When between 5.0 and 10.0 percent and less than 15.0 percent of all measurements made within a lot exceed the tolerance specified in paragraph "Smoothness Requirements" above, after any reduction of high spots or removal and replacement, the computed percent payment based on surface smoothness will be 95 percent. When more than 10.0 percent and less than 15.0 percentof all measurements exceed the tolerance, the computed percent payment will be 90 percent. When between 15.0 and 20.0 percent of all measurements exceed the tolerance, the computed percent payment will be 75 percent. When 20.0 percent or more of the measurements exceed the tolerance, the lot shall be removed and replaced at no additional cost to the Government. Regardless of the above, any small individual area with surface deviation which exceeds the tolerance given above by more than 50 percent shall be corrected by grinding to meet the specification requirements above or shall be removed and replaced at no additional cost to the Government.

b. Profilograph Testing: Location and data from all profilograph measurements shall be recorded. When the Profile Index of a lot exceeds the tolerance specified in paragraph "Smoothness Requirements" above by 1.0 inch per mile but less than 2.0 inches per mile, after any reduction of high spots or removal and replacement, the computed percent payment based on surface smoothness will be 95 percent. When the Profile Index exceeds the tolerance by 2.0 inches per mile but less than 3.0 inches per mile, the computed percent payment will be 90 percent. When the Profile Index exceeds the tolerance by 3.0 inches per mile but less than 4.0 inches per mile, the computed percent payment will be 75 percent. When the Profile Index exceeds the tolerance by 4.0 inches per mile or more, the lot shall be removed and replaced at no additional cost to the Government. Regardless of the above, any small individual area with surface deviation which exceeds the tolerance given above by more than 5.0 inches per mile or more, shall be corrected by grinding to meet the specification requirements above or shall be removed and replaced at no additional cost to the Government.

c. Bumps ("Must Grind" Areas): Any bumps ("must grind" areas) shown on the profilograph trace which exceed 0.4 inch in height shall be reduced by grinding in accordance with subparagraph "Areas Defective In Plan Grade Or Smoothness" until they do not exceed 0.3 inch when retested. Such grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. Areas of textured pavement shall be retextured in accordance with the subparagraph listed above. At the Contractor's option, pavement areas including ground areas may be rechecked with the profilograph in order to record a lower Profile Index.

1.4.8 Edge Slump and Joint Face Deformation

****

NOTE: Delete this series of paragraphs if no pavements are 250 mm (10 inches) or more in thickness or if slipform paving is not allowed.

****

The following requirements on testing and evaluation of edge slump and joint face deformation apply only to pavements 10 inches or more in thickness. Use of slip-form paving equipment and procedures that fail to consistently provide edges within the specified tolerances on edge slump and joint face deformation shall be discontinued and the pavements shall be constructed by means of standard paving procedures using fixed forms. Slabs having more than the allowable edge slump shall be removed and replaced as specified in subparagraph "Excessive Edge Slump" before the adjacent lane is placed. Edge slump and joint face deformation will not be applied to payment adjustment.

1.4.8.1 Edge Slump

When slip-form paving is used, not more than 15.0 percent of the total free edge of any slab of the pavement, as originally constructed, shall have an edge slump exceeding 1/4 inch, and no slab shall have an edge slump exceeding 3/8 inch as determined in accordance with the measurements as specified in paragraph "Determination of Edge Slump". (The total free edge of the pavement will be considered to be the cumulative total linear measurement of pavement edge originally constructed as non-adjacent to any existing pavement; i.e., 100 feet of pilot lane, a paving lane originally constructed as a separate lane, will have 200 feet of free edge; 100 feet of fill-in lane will have no free edge, etc.,). The area affected by the downward movement of the concrete along the pavement edge shall not exceed 18 inches back from the edge.

1.4.8.2 Joint Face Deformation

In addition to the edge slump limits specified above, the vertical joint face shall have a surface within the maximum limits shown below:

	Offset from Straightedge Applied Longitudinally To Pavement Surface 1 Inch Back From Joint Line	Offset From Straightedge Applied Longitudinally to Vertical Face	Offset From Straightedge Applied Top to Bottom Against the Joint Face	Abrupt Offset in Any Direction	Offset of Joint Face From True Vertical
Airfield Pavement	1/8 inch	1/4 inch	3/8 inch	1/8 inch	1 inch per 12 inches
All other Pavement	1/4 inch	All other items same as airfield pavement.			

1.4.8.3 Determination of Edge Slump

Immediately after the concrete has hardened sufficiently to permit walking thereon, the pavement surface shall be tested by the Contractor in the presence of a representative of the Contracting Officer. Testing shall be performed with a straightedge to reveal irregularities exceeding the edge slump tolerance specified above. The edge slump shall be determined at each free edge of each slipformed paving lane constructed. The straightedge shall be placed transverse to the direction of paving and the end of the straightedge located at the edge of the paving lane.

Measurements shall be made at 5 to 15 foot spacings, as directed, commencing at the header where paving was started. Initially measurements shall be made at 5 foot intervals in each lane. When no deficiencies are present, the Contracting Officer may approve an increase in the interval. When any deficiencies exist, the interval will be returned to 5 feet. In no case shall the interval exceed 15 feet. In addition to the transverse edge slump determination above, the Contractor, at the same time, shall check the longitudinal surface smoothness of the joint on a continuous line 1 inch back from the joint line using the straightedge advanced one-half its length for each reading. Other tests of the exposed joint face shall be made as directed to ensure that a uniform, true vertical joint face is attained. These tests shall include longitudinal straightedge testing of the vertical face and vertical testing of the face for both smoothness and angle. The measurements shall be made by the Contractor, shall be properly referenced in accordance with paving lane identification and stationing, and a report given to the Contracting Officer within 24 hours after measurement is made. The report shall also identify areas requiring replacement in accordance with paragraph "Excessive Edge Slump" as well as the cumulative percentage of total free edge of pavement constructed to date which has an edge slump exceeding 1/4 inch.

1.4.8.4 Excessive Edge Slump

When edge slump exceeding the limits specified above is encountered on either side of the paving lane, additional straightedge measurements shall be made, if required, to define the linear limits of the excessive slump. The concrete for the entire width of the paving lane within these limits of excessive edge slump or joint deformation shall be removed and replaced in conformance with paragraph REPAIR, REMOVAL, REPLACEMENT OR SLABS. Partial slabs removed and replaced shall extend across the full width of the pavement lane, parallel to the transverse joints, and both the section of the slab removed and the section remaining in place shall have a minimum length of 10 feet to the nearest scheduled transverse joint. If less than 10 feet remains, the entire slab shall be removed and replaced. Adding concrete or paste to the edge or otherwise manipulating the plastic concrete after the sliding form has passed, or patching the hardened concrete, shall not be used as a method for correcting excessive edge slump.

1.4.9 Plan Grade

1.4.9.1 Plan Grade Tolerances

The finished surfaces of pavements shall conform, within the tolerances shown below, to the lines, grades, and cross sections shown. The finished surfaces of airfield runway, taxiway, and apron pavements shall vary not more than 1/2 inch above or below the plan grade line or elevation indicated. The surfaces of other pavements shall vary not more than 3/4 inch. Plan grade shall be checked on the lot as a whole and when more than 5.0 and less than 10.0 percent of all measurements made within a lot are outside the specified tolerance, the computed percent payment for that lot will be 95 percent. When more than 10.0 percent are outside the specified tolerances, the computed percent payment for the lot will be 75 percent. However, in any areas where the deviation from grade exceeds the specified tolerances by 50 percent or more, the deficient area shall be removed and replaced at no additional cost to the Government. However, the above deviations from the approved grade line and elevation will not be permitted in areas where closer conformance with the planned grade and elevation is required for the proper functioning of appurtenant structures. The finished surfaces of new abutting pavements shall coincide at their juncture.

1.4.9.2   Grade Conformance Tests

Each pavement category shall be checked by the Contractor for conformance with plan grade requirements. For the purpose of making grade conformance tests, the pavements will be subdivided into the same lots used for all other payment adjustment items. Within 5 days after paving of each lot, the finished surface of the pavement area in each lot shall be tested by the Contractor, in the presence of a representative of the Contracting Officer, by running lines of levels at intervals corresponding with every longitudinal and transverse joint to determine the elevation at each joint intersection. The results of this survey shall be recorded and a copy given to the Government at the completion of the survey of each lot.

1.4.10   Flexural Strength

****

NOTE: Normally, concrete for airfield pavement should be proportioned and accepted on the basis of 90-day flexural strength. However, if, because of scheduling time limits, it is necessary to proportion on the basis of 28-day flexural strength, modify these subparagraphs as appropriate. If it is desired to use 28-day strength for design of airfield pavement, approval must be obtained through the TSMCX. Make the same changes if this is concrete for road pavement proportioned for 28-day strength (no HQUACE or TSMCX approval needed). Delete the last sentence of this paragraph only if deletion is approved by HQUSACE (CEMP-ET).

****

Each lot of pavement will be evaluated for acceptance in accordance with the following procedures. The Contractor shall be responsible for all testing required herein. Testing shall be performed by an approved commercial laboratory. Results of strength tests will not be used for payment adjustment.

1.4.10.1   Sampling and Testing

One composite sample of concrete from each sublot shall be obtained in accordance with ASTM C 172 from one batch or truckload. Test cylinders, 6 x 12 in. shall be fabricated and cured in accordance with ASTM C 31/C 31M; and tested in accordance with ASTM C 39. Two test cylinders per sublot (8 per lot) shall be fabricated and cured for compressive strength, and two tested at 14-day age and two at 28-day age The remaining four shall be tested at the ages directed. At the same time 2 additional test cylinders per sublot to be used for CQC tests shall be fabricated and cured; and tested as specified in paragraph TESTING AND INSTECTION FOR CONTRACTOR QUALITY CONTROL. Two beams for flexural strength shall be fabricated and cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 78 for every 2500 cubic yards of concrete. These shall be tested at the ages directed.

1.4.10.2   Computations

The following computations shall be performed:

a. Average the eight 14-day compressive strength tests for the lot and also compute the standard deviation(s) for the eight tests.

b. Convert the 14-day average compressive strength for the lot to equivalent 90-day average flexural strength for the lot, using the Correlation Ratio determined during mixture design studies.

c. Report results of strength tests to the Contracting Officer daily. These values will be used for acceptance, but will not be used for payment adjustment.

1.4.11 Thickness

****
NOTE: Edit for pavement thickness.
****

Each lot of pavement will be evaluated for acceptance and payment adjustment in accordance with the following procedure. The Contractor shall be responsible for drilling the cores, measuring the cores in the presence of the Contracting Officer's representative, and for filling the core holes as directed.

1.4.11.1 Drilling, Measuring, and Computations

Two cores, between 3 and 6 in. in diameter, shall be drilled from the pavement, per sublot (8 per lot). The Contractor shall fill the core holes with concrete containing an expanding admixture, as directed. The cores shall be evaluated for thickness of the pavement in accordance with ASTM C 174/C 174M. The pavement thickness from the 8 cores for the lot shall be averaged and the standard deviation for the 8 thickness measurements shall be computed.

1.4.11.2 Evaluation and Payment Adjustment for Thickness

Using the Average Thickness of the lot, the computed percent payment for thickness shall be determined by entering the following table:

Pavements Over 8 inches In Thickness

Deficiency in Thickness Determined by Cores Inches	Computed Percent Payment for Thickness
0.00 to 0.24	100
0.25 to 0.49	75
0.50 to 0.74	50
0.75 or greater	0

Pavements 8 inches or Less In Thickness

Deficiency in Thickness Determined by Cores Inches	Computed Percent Payment for Thickness
0.00 to 0.24	100
0.25 to 0.49	65
0.50 or greater	0

Where 0 percent payment is indicated, the entire lot shall be removed and replaced at no additional cost to the Government. Where either of the two cores from a sublot show a thickness deficiency of 0.75 inchor greater, two more cores shall be drilled in the sublot and the average thickness of the four cores computed. If this average shows a thickness deficiency of 0.75 inch or more [0.50 inch for pavements 8 inches or less in thickness] the entire sublot shall be removed.

1.4.12 Partial Lots

When operational conditions cause a lot to be terminated before the specified four sublots have been completed, the following procedure shall be used to adjust the lot size and number of tests for the lot. Where three sublots have been completed, they shall constitute a lot and acceptance criteria adjusted accordingly. Where one or two sublots have been completed, they shall be incorporated into the next lot or the previous lot, as directed, and the total number of sublots shall be used and acceptance criteria adjusted accordingly.

1.4.13 Areas Defective in Plan Grade or Smoothness

In areas not meeting the specified limits for surface smoothness and plan grade, high areas shall be reduced to attain the required smoothness and grade, except as depth is limited below. High areas shall be reduced either by hand rubbing the freshly finished concrete with a silicon carbide brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 14 days or more old. Rubbing with a silicon carbide brick and water shall be discontinued as soon as contact with the coarse aggregate is made, and all further necessary reduction shall be accomplished by grinding the hardened concrete with a surface-grinding machine after it is 14 days old. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and shall not exceed 1 percent of the total area of any sublot. The depth of grinding shall not exceed 1/4 inch. All pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified above, shall be removed and replaced in conformance with paragraph REPAIR, REMOVAL, REPLACEMENT OF SLABS. In pavement areas given a wire comb or tined texture, areas exceeding 25 square feet that have been corrected by rubbing or grinding shall be retextured by transverse grooving using an approved grooving machine of standard manufacture. The grooves shall be 1/8 inch deep by 1/4 inch wide on 2 inch centers and shall be carried into, and tapered to zero depth within the non-corrected surface, or shall match any existing grooves in the adjacent pavement. All areas in which rubbing or grinding has been performed will be subject to the thickness tolerances specified in paragraph Thickness. Any rubbing or grinding performed on individual slabs with excessive deficiencies shall be performed at the Contractor's own decision without entitlement to additional compensation if eventual removal of the slab is required.

1.5 ACCEPTABILITY OF WORK

The materials and the pavement itself will be accepted on the basis of tests made by the Government and by the Contractor's approved commercial laboratory or the supplier's approved laboratory, all as specified herein. The Government may, at its discretion, make check tests to validate the results of the Contractor's testing. If the results of the Government and Contractor tests vary by less than 2.0 percent, of the Government's test results, the results of the Contractor's tests will be used. If the results of the Government and Contractor tests vary by 2.0 percent or more, but less than 4.0 percent, the average of the two will be considered the value to be used. If these vary by 4.0 percent or more, each sampling and testing procedure shall be carefully evaluated and both the Government and the Contractor shall take another series of tests on duplicate samples of material. If these vary by 4.0 percent or more, the results of the tests made by the Government shall be used and the Government will continue check testing of this item on a continuous basis until the two sets of tests agree within less than 4.0 percent on a regular basis. Testing performed by the Government will in no way at any time relieve the Contractor from the specified testing requirements.

1.6 PRECONSTRUCTION TESTING OF MATERIALS

****

NOTE: Designer must edit this paragraph and following subparagraphs as appropriate depending on whether Government or Contractor testing is desired. Delete any subparagraphs which are not applicable. Fill in blanks as appropriate.

****

The Contractor shall not be entitled to any additional payment or extension of time because of delays caused by sampling and testing additional sources, or samples, necessitated by failure of any samples.

1.6.1 Aggregates

Aggregates shall be sampled by the Contractor in the presence of a Government representative. Samples shall be obtained in accordance with COE CRD-C 100 and of the size indicated therein, or larger if specified in paragraph Testing Sequence Deleterious Materials -- Airfields Only and shall be representative of the materials to be used for the project. [Samples shall be delivered by the Contractor to [_____], at least [_____] days prior to start of construction. Samples will be tested by the Government to determine compliance with these specifications.] [Testing of samples shall be the responsibility of the Contractor and shall be performed by an approved commercial laboratory. Test results shall be submitted [_____] days before commencing paving.] No material shall be used unless test results show that it meets all requirements of these specifications.

1.6.2 Chemical Admixtures

The Contractor shall provide satisfactory facilities for ready procurement of adequate test samples. All sampling and testing of an admixture will be by and at the expense of the Government. Tests will be conducted with materials proposed for the project. An air-entraining admixture that has been in storage at the project site for longer than 6 months or that has been subjected to freezing will be retested at the expense of the Contractor when considered appropriate and shall be rejected if test results are not satisfactory.

1.6.3 Curing Compound

The Contractor shall provide satisfactory facilities for ready procurement of adequate test samples. The sampling and testing will be by and at the expense of the Government.

1.6.4 Epoxy-Resin Material

At least 30 days before the material is used, the Contractor shall submit certified copies of test results showing that the specific lots or batches from which the material will be furnished to this project have been tested by the manufacturer and that the material conforms to the requirements of these specifications. When epoxy resin arrives at the job site, the Contractor shall assist the Government to sample the material. The Government will test the sample or will retain it in storage for possible future testing, as considered appropriate.

1.6.5 Cements, Pozzolans, and GGBF Slag

Preconstruction sampling and testing of cement, pozzolan, and GGBF slag shall conform to the requirements specified for sampling and testing during construction except that test results showing that each material meets specification requirements shall be available at least 5 days before start of paving operations.

1.7 TESTING BY CONTRACTOR DURING CONSTRUCTION

****

NOTE: Use the following two subparagraphs when testing is by the Contractor.

****

1.7.1 Contractor's Testing Requirements

During construction, the Contractor shall be responsible for sampling and testing aggregates, cementitious materials (cement and pozzolan), and concrete to determine compliance with the specifications. All sampling and testing shall be performed by an approved commercial laboratory, or for cementitious materials, the manufacturer's laboratory. Samples of aggregate shall be obtained as the bins discharge into the the weigh hopper. Samples of concrete shall be obtained at the point of delivery to the paver. The Government will sample and test concrete and ingredient materials as considered appropriate. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Testing by the Government will in no way relieve the Contractor of the specified testing requirements.

1.7.2 Cementitious Materials

Cement [, ground granulated blast furnace (GGBF) slag,] and pozzolan will be accepted on the basis of manufacturer's certification of compliance, accompanied by mill test reports showing that the material in each shipment meets the requirements of the specification under which it is furnished. No cementitious material shall be used until notice of acceptance has been given by the Contracting Officer. Cementitious material may be subjected to check testing by the Government from samples obtained at the mill, at transfer points, or at the project site.

1.8 TESTING BY GOVERNMENT DURING CONSTRUCTION

****

NOTE: For all but the most important projects, use of mill test results for acceptance of cementitious materials, as written in the text, will normally be appropriate and reference to full Government sampling and testing, or prequalified sources, as specified below should not be used. Do not mix or use both methods together. Be aware that the Government (project funds) must pay CEWES for any Government testing, including that which is always required when prequalified sources are used, and that prequalification applies only to a specific "type" of cement at any plant.

****

1.8.1 Government Testing

During construction, the Government will be responsible for sampling and testing aggregates, cementitious materials (cement and pozzolan), and concrete to determine compliance with the specifications. Samples of aggregate will be obtained as the bin discharges into the weigh hopper. Samples of concrete will be obtained at the point of delivery to the paver. The Government will sample and test concrete and ingredient materials as considered appropriate. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Testing by the Government will in no way relieve the Contractor of the specified testing requirements.

1.8.2 Cementitious Materials

****

NOTE: To get the current cost of testing cementitious material to insert in the blanks, contact CEWES-SC.

****

Cementitious materials shall be furnished either from sources tested by the Government especially for this project or from prequalified sources, at the Contractor's option. Cementitious material will be sampled at the mill or shipping point or at the site of the work and tested by and at the expense of the Government. If tests prove that a cementitious material that has been delivered is unsatisfactory, it shall be promptly removed from the site of the work. Cementitious material that has not been used within 6 months after testing will be retested by the Government at the expense of the Contractor when directed by the Contracting Officer and shall be rejected if test results are not satisfactory. The cost of testing cementitious material excess to the project requirements will also be at the expense of the Contractor. The charges for testing at the expense of the Contractor will be deducted from the payments due the Contractor at the rate of [_____] per lb of portland cement [blended cement], [GGBF slag] [silica fume] represented by the tests, and for testing pozzolan at a rate of [_____] per cubic foot solid volume.

1.8.2.1 Prequalified Cement and Pozzolan

Cement or pozzolan shall be delivered and used directly from the mill of a producer designated as a prequalified source specifically for the particular "type" of cement or pozzolan involved (including any supplementary requirements). Samples of cement or pozzolan for check testing will be taken at the project site or the concrete producing plant by a representative of the Contracting Officer for testing at the expense of the Government. A list of prequalified cement and pozzolan sources is available from the Commander, U.S. Army Engineer Waterways Experiment Station (ATTN: CEWES-SC), 3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199.

1.8.2.2 Cement Sources Not Prequalified

The sampling, testing, and, when the point of sampling is other than the site of the work, the inspection during shipping will be made by the Government at its expense. Cement meeting all other requirements will be accepted before the required 7-day age when the strength is equal to or greater than the 7-day requirement. In the event of failure, the cement may be resampled at the request of the Contractor and at its expense. When the point of sampling is other than the site of the work, the fill gate or gates of the sampled bin will be sealed and kept sealed until shipment from the bin has been completed. Sealing of fill gates and of conveyances used in shipment will be done by the Government. Conveyances will not be accepted at the site of the work unless received with all seals intact. If tested cement is rehandled at transfer points, the extra cost of inspection will be at the Contractor's expense.

1.8.2.3 Pozzolan Sources Not Prequalified

Pozzolan will be sampled at the source and shall be stored in sealed bins pending completion of required tests. When determined necessary, pozzolan will also be stored at the site. All sampling and testing will be performed by the Government. Release for shipment and approval for use will be based on compliance with 7-day lime-pozzolan strength requirements and other physical, chemical, and uniformity requirements for which tests can be completed by the time the 7-day lime-pozzolan strength test is completed, as well as on continuing compliance with the other requirements of the specifications. If the sample from a bin fails, the contents of the bin may be resampled and tested at the Contractor's expense. In this event, pozzolan may be sampled as it is loaded into cars or trucks, provided they are kept at the source until released for shipment. Unsealing and resealing of bins and sealing of shipping conveyances will be done by the Government. Shipping conveyances will not be accepted at the site of the work unless they are received with all seals intact. If pozzolan is damaged in shipment, handling, or storage, it shall be promptly removed from the site of the work. Pozzolan not used within 6 months after testing will be retested by the Government at the expense of the Contractor and shall be rejected if the test results are not satisfactory. If tested pozzolan is rehandled at transfer points, the extra cost of inspection will be at the Contractor's point of delivery to the paver. The Government will sample and test concrete and ingredient materials as considered appropriate. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Testing by the

Government will in no way relieve the Contractor of the specified testing requirements.

1.8.2.4 Mill Tests for Cementitious Materials

Cement,[ground granulated blast furnace (GGBF) slag], and pozzolan will be accepted on the basis of manufacturer's certification of compliance accompanied by mill test reports showing that the material in each shipment used meets the requirements of the spedification under which it is furnished. No cementitious material shall be used until notice of acceptance has been given by the Contracting Officer. Cementitious material may be subjected to check testing by the Government on samples obtained at the mill, at transfer points, or at the project site.

1.9 SAMPLES FOR MIXTURE PROPORTIONING STUDIES

****

NOTE: Use this paragraph if the Government is to perform the mixture proportioning studies or if it is desired to have samples available for the Government to make check tests of Contractor developed mixtures. Otherwise, delete the paragraph and edit the submittals paragraph accordingly. Edit bracketed items appropriately. Contact the CEWES Laboratory for required lead time and for quantities of material to insert in the blanks. Insert the CEWES Laboratory address for delivery of materials.

****

At least [_____] days in advance of the time when placing of concrete is expected to begin, samples of representative materials proposed for this project shall be delivered to [_____] by the Contractor at its expense. Samples will be used by the Government for mixture proportioning studies [to develop the concrete mixture for use on the project] [to perform check tests of the Contractor's proposed concrete mixture proportions], as considered appropriate. Samples of approved aggregates shall be taken under the supervision of the Contracting Officer in accordance with COE CRD-C 100, and shall be delivered accompanied by test reports indicating conformance with grading and quality requirements specified. Samples of materials other than aggregates shall be representative of those proposed for the project and shall be submitted accompanied by the manufacturer's test reports showing compliance with applicable specified requirements. If any of the materials submitted do not meet specified requirements or if the materials do not produce concrete of the strength or quality specified, replacement samples of different acceptable materials shall be immediately submitted. When this requires additional mixture proportioning studies, the Contractor will be charged [_____] per additional study. The Contractor will be entitled to no additional compensation or extension of time because of delays caused by resubmittals or additional mixture proportioning studies. Quantities of materials required shall be as shown in Table 3.

TABLE 3

Material	Quantity
Coarse aggregate 1-1/2 inch nominal maximum size	[_____] pounds

TABLE 3

Material	Quantity
Coarse aggregate 3/4 inch	[_____] pounds
Fine aggregate	[_____] pounds
Portland Cement	[_____] pounds
Blended Cement	[_____] pounds
Pozzolan	[_____] pounds
Silica Fume	[_____] pounds
Ground Granulated Blast Furnace Slag	[_____] pounds
Air-entraining admixture	[_____] quarts
Other admixtures (each)	[_____] quarts

1.10 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment; [_____].

a. Details and data on the batching and mixing plant prior to plant assembly including manufacturer's literature showing that the equipment meets all requirements specified herein.

b. A description of the equipment proposed for transporting concrete mixture from the central mixing plant to the paving equipment at least 7 days prior to start of paving unless otherwise specified.

c. At the time the materials are furnished for the mixture proportioning study, a description of the equipment proposed for the placing of the concrete mixture, method of control, and manufacturer's literature on the paver and finisher, together with the manufacturer's written instructions on adjustments and operating procedures necessary to assure a tight, smooth surface on the concrete pavement, free of tears and other surface imperfections, including excessive paste on the surface. The literature shall show that the equipment meets all details of these specifications.

Work Plan; GA.

a. A description of the placing and protection methods proposed prior to construction of the test section, if concrete is to be placed in or exposed to hot or cold weather conditions.

b. A detailed plan of the proposed paving pattern showing all planned construction joints. No deviation from the jointing pattern shown on the drawings shall be made without written approval of the [_____] District Geotechnical Branch.

c. Data on the curing media and methods to be used.

SD-08 Statements

Samples for Mixture Proportioning Studies; GA.

The results of the Contractor's mixture proportioning studies along with a statement giving the maximum nominal coarse aggregate size and the proportions of all ingredients that will be used in the manufacture of concrete at least 14 days prior to commencing concrete placing operations. Aggregate quantities shall be based on the mass in a saturated surface dry condition. The statement shall be accompanied by test results from an independent commercial testing laboratory, inspected by the Government, and approved in writing, showing that mixture proportioning studies have been made with materials proposed for the project and that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the mixture proportions without additional tests to show that the quality of the concrete is satisfactory.

SD-09 Reports

Sampling and Testing; GA.

Certified copies of laboratory test reports, including all test data, for cement, pozzolan, aggregate, admixtures, and curing compound proposed for use on this project. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials. No material shall be used until notice of acceptance has been given. Materials may be subjected to check testing by the Government from samples obtained at the manufacturer, at transfer points, or at the project site.

SD-18 Records

Delivery, Storage, and Handling of Materials; [_____].

Copies of waybills or delivery tickets for cementitious material during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all cementitious material used in the construction.

1.11 QUALIFICATIONS

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NOTE: Where they are available, specify only ACI certified personnel.
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All Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) Certified Workmen in one of the following grades (or shall have approved written evidence of having completed similar qualification programs):

Concrete Field Testing Technician, Grade I
Concrete Laboratory Testing Technician, Grade I or II
Concrete Construction Inspector, Level II

The foreman or lead journeyman of the finishing crew shall have similar qualification for ACI Concrete Flatwork Technician/Finisher, or equal. Written documentation shall be furnished for each workman in the above groups.

1.12 TEST SECTION

****
NOTE: Retain this paragraph if slipforming of pavements more than 250 mm (10 inches) thick is permitted. Where desired for other pavements, retain it; otherwise, delete. Edit bracketed items as appropriate. Use bracketed item requiring cutting of cores and beams only for special concerns. Normally it is best to use the bracketed item requiring the test section to be separate from the production pavement (Easier to administer.)
****

At least 10 days but not more than 60 days prior to construction of the concrete pavement, a test section shall be constructed [near the job site [,but not as part of the production pavement area,] at the location designated on the contract plans] [as part of the production paving area at an outer edge as indicated on the drawings. If part of the production paving area, the test section will be allowed to remain in place, if meeting all specification requirements and will be paid for as part of the production pavement]. There will be no separate payment for the test section or sections and the cost of the materials, and the construction will be considered a subsidiary cost of constructing the project. The Contractor shall notify the Contracting Officer at least 5 days in advance of the date of test section construction. The test section shall consist of one paving lane at least 400 feet long and shall be constructed to a thickness of [_____] inches. The lane width shall be the same as that required for use in the project. The test section shall contain at least one transverse construction joint. If keyed or doweled longitudinal construction joints are required in any of the production pavements, they shall be installed full length along one side of the test strip throughout the test section. If both keys and dowels are required, each shall be installed in half of the test section. Two separate days shall be used for construction of the test section. The Contractor shall use the test section to develop and demonstrate to the satisfaction of the Contracting Officer the proposed techniques of mixing, hauling, placing, consolidating, finishing, curing, start-up procedures, testing methods, plant operations, and the preparation of the construction joints. Variations in mixture proportions other than water shall be made if directed. The test section shall be placed as approved by the Government. The Contractor shall vary the water content, as necessary, to arrive at the appropriate content. The mixing plant shall be operated and calibrated prior to start of placing the test section. The Contractor shall use the same equipment, materials, and construction techniques on the test section as will be used in all subsequent work. Base course preparation, concrete production, placing, consolidating, curing, construction of joints, and all testing shall be in accordance with applicable provisions of this specification. The Contractor shall construct the test section meeting all specification requirements and being acceptable to the Contracting Officer in all aspects, including surface texture. Failure to construct an acceptable test section will necessitate construction of additional test sections at no additional cost to the Government. [Test sections allowed to be constructed as part of the production paving which do not meet specification requirements shall be removed at the Contractor's expense.] [Any test sections unacceptable to the Contracting Officer shall be removed at the Contractor's expense.] If the Contractor proposes to use slipform paving and is unable to construct an acceptable test section, or if the slipform paving equipment and procedures are found to be unable to produce acceptable pavement at any time, the slipform paving equipment shall be removed from the job and the construction completed using stationary side forms and equipment compatible with them. [The Contractor shall provide four cores at least 6 inch diameter and 2 beams at least 6 by 32 inches by full depth (or 4 beams at least 6 by 20 inches by full depth) cut from points selected in the test section by the Government, 5 days after completion of the test section. The Contractor shall trim the beams to dimensions directed before delivery for inspection and testing, as considered appropriate.] Production paving may be started immediately after the results of 7-day tests of the cores (and the sawed beams) have been approved and after approval of the test section.

1.13 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

****
NOTE: Delete bracketed items if not appropriate.
****

1.13.1 Bulk Cementitious Materials

All cementitious material shall be furnished in bulk. The temperature of the cementitious material, as delivered to storage at the site, shall not exceed 150 degrees F.

1.13.1.1 Transportation

When bulk cementitious material is not unloaded from primary carriers directly into weather-tight hoppers at the batching plant, transportation from the railhead, mill, or intermediate storage to the batching plant shall be accomplished in adequately designed weather-tight trucks, conveyors, or other means that will protect the cementitious material from exposure to moisture.

1.13.1.2 Storage Requirements

Immediately upon receipt at the site of the work, cementitious materials shall be stored in a dry and properly ventilated structure. All storage facilities shall be subject to approval and shall allow easy access for inspection and identification. Sufficient cementitious materials shall be in storage to sustain continuous operation of the concrete mixing plant while the pavement is being placed. To prevent cement from becoming unduly aged after delivery, any cement that has been stored at the site for 60 days or more shall be used before using cement of lesser age.

1.13.1.3 Separation of Materials

Separate facilities shall be provided which will prevent any intermixing during unloading, transporting, storing, and handling of each type of cementitious material.

1.13.2 Aggregate Materials

1.13.2.1 Storage

Aggregate shall be stored at the site of the batching and mixing plant avoiding breakage, segregation, or contamination by foreign materials. Each size of aggregate from each source shall be stored separately in free-draining stockpiles. Fine aggregate and the smallest size coarse aggregate shall remain in free-draining storage for at least 24 hours immediately prior to use. Sufficient aggregate shall be maintained at the site at all times to permit continuous uninterrupted operation of the mixing plant at the time concrete pavement is being placed.

1.13.2.2 Handling

Aggregate shall be handled avoiding segregation or degradation. Vehicles used for stockpiling or moving aggregate shall be kept clean of foreign materials. Tracked equipment shall not be allowed on coarse aggregate stockpiles. Stockpiles shall be built up and worked avoiding segregation in the piles and preventing different sizes of aggregate from being mixed during storage or batching. Aggregate shall not be stored directly on ground unless a sacrificial layer is left undisturbed and unused.

1.13.3 Other Materials

Reinforcing bars and accessories shall be stored above the ground on platforms, skids, or other supports. Other materials shall be stored avoiding contamination and deterioration. Chemical admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not be used unless retested and proven to meet the specified requirements. The Contractor shall ensure that materials can be accurately identified after bundles or containers are opened.

1.14 EQUIPMENT

All plant, equipment, tools, and machines used in the work shall be maintained in satisfactory working conditions at all times.

1.14.1 Batching and Mixing Plant

1.14.1.1 Location of Batching and Mixing Plant

****

NOTE: The batching and mixing plant should be on the construction site or as close as possible, but should be no farther than 15 minutes haul time from the placing site during all periods of the work day. Edit bracketed items as appropriate.
****

The batching and mixing plant shall be located [on project site as indicated on the drawings] [off Government promises no more than 15 minutes haul time from the placing site]. There shall be operable telephonic or radio communication between the batching plant and the placing site at all times concreting is taking place.

1.14.1.2 Type and Capacity of Batching and Mixing Plant

****
NOTE: Edit as appropriate. Plant capacity should be governed by the laydown pattern or the size of the job to prevent delay of paving operations.
****

The batching and mixing plant shall be a stationary-type plant. The plant shall be designed and operated to produce concrete within the specified tolerances, and shall have a capacity of at least 250 cu. yd. [_____] per hour. The batching plant shall conform to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required.

1.14.1.3 Equipment Requirements

The batching controls shall be either semiautomatic or automatic. Semiautomatic batching system shall be provided with interlocks. Separate bins or compartments shall be provided for each size group of aggregate and each cementitious material. Aggregates shall be weighed either in separate weigh batchers with individual scales or cumulatively in one weigh batcher on one scale, provided the fine aggregate is weighed first. Aggregate shall not be weighed in the same batcher with cementitious material. If both cement and pozzolan are used, they may be batched cumulatively, provided portland cement is batched first. Water shall not be weighed or measured cumulatively with another ingredient. Water batcher filling and discharging valves shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. An accurate mechanical device for measuring and dispensing each chemical admixture shall be provided. Each dispenser shall be interlocked with the batching cycle and discharged automatically to obtain uniform distribution throughout the batch in the specified mixing period. Different chemical admixtures shall not be combined before introduction in water and cement. The plant shall be arranged to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each bin or compartment.

1.14.1.4 Scales

Adequate facilities shall be provided for the accurate measurement and control of each of the materials entering each batch of concrete. The weighing equipment shall conform to the applicable requirements of NIST HB 44, except that the accuracy shall be within 0.2 percent of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring device. Each weighing unit shall include a visible springless dial, which shall indicate the scale load at all stages of the weighing operation or shall include a beam scale with a beam balance indicator that will show the scale in balance at zero load and at any beam setting. The indicator shall have an over and under travel equal to at least 5 percent of the capacity of the beam. Approved electronic digital indicators and load cells may also be used. The weighing equipment shall be arranged to allow the concrete plant operator to conveniently observe the dials or indicators.

1.14.1.5 Batching Tolerances

The following tolerances shall apply.

Materials	Percentage of Required Mass
Cement (and Pozzolan)	plus or minus 1
Aggregate	plus or minus 2
Water	plus or minus 1
Admixture	plus or minus 3

For volumetric batching equipment for water and admixtures, the above numeric tolerances shall apply to the required volume of material being batched. Concentrated admixtures shall be uniformly diluted, if necessary, to provide sufficient volume per batch to ensure that the batchers will consistently operate within the above tolerance.

1.14.1.6 Moisture Control

****
NOTE: Edit as appropriate for project.
****

The plant shall be capable of ready adjustment to compensate for the varying moisture contents of the aggregates and to change the quantities of the materials being batched. [An electric moisture meter complying with the provisions of COE CRD-C 143 shall be provided for measuring of moisture in the fine aggregate. The sensing element shall be arranged so that measurement is made near the batcher charging gate of the fine aggregate bin or in the fine aggregate batcher.]

1.14.1.7 Recorders

A graphic or digital recorder conforming to the requirements of NRMCA CPMB 100 shall be furnished and kept operational at the batching plant.

1.14.2 Concrete Mixers

****
NOTE: Edit bracketed items according to whether use of truck mixers is to be permitted. Truck mixers should not be permitted for mixing or transporting concrete if slipform paving is permitted for pavement thicker than 200 mm (8 inches).
****

Mixers shall be [stationary] [truck] mixers. [Truck mixers shall not be used for mixing or transporting paving concrete.] Mixers shall be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. The mixers shall not be charged in excess of the capacity recommended by the manufacturer. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The mixers shall be maintained in satisfactory operating condition, and the mixer drums shall be kept free of hardened concrete. Mixer blades or paddles shall be replaced when worn down more than 10 percent of their depth when compared with the manufacturer's dimension for new blades or paddles.

1.14.2.1 Stationary, Central Plant, Mixers

Stationary mixers shall be [drum mixers of [tilting] [nontilting] [horizontal-shaft] [vertical-shaft] type] [pug mills]. Mixers shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed.

1.14.2.2 Truck Mixers

****

NOTE: Retain this subparagraph only if truck mixers have been permitted above.

****

The only truck mixers used for mixing or transporting paving concrete shall be those designed with extra large blading and rear opening specifically for low-slump paving concrete. Truck mixers, the mixing of concrete therein, and concrete uniformity and testing thereof shall conform to the requirements of ASTM C 94. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall be equipped with two counters which will show the number of revolutions at mixing speed and the number of revolutions at agitating speed. Concrete completely mixed in a truck mixer shall be mixed 70 to 100 revolutions at the designated mixing speed after all ingredients, including mixing water, have been charged into the drum. Concrete first partially mixed in a concrete plant mixer (shrink-mixed) a minimum time, as required to combine the ingredients, shall then be completely mixed in a truck mixer. The number of revolutions between 70 to 100 for truck-mixed concrete and the number of revolutions for shrink-mixed concrete shall be determined by uniformity tests as specified in ASTM C 94 and in requirements for mixer performance stated in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL. If requirements for the uniformity of concrete are not met with 100 revolutions of mixing after all ingredients including water are in the truck mixer drum, the mixer shall not be used until the condition is corrected. Additional revolutions beyond the number determined to produce the required uniformity shall be at the designated agitating speed. Water shall not be added after the initial introduction of mixing water except, when on arrival at the job site, the slump is less than specified and the water-cement ratio is less than that given as a maximum in the approved mixture. Additional water may be added to bring the slump within the specified range provided the approved water-cement ratio is not exceeded. Water shall be injected into the head of the mixer (end opposite the discharge opening) drum under pressure, and the drum or blades shall be turned a minimum of 30 additional revolutions at mixing speed. Water shall not be added to the batch at any later time.

1.14.2.3   Mixing Time and Uniformity

****
NOTE: Retain bracketed subparagraph if truck mixers are permitted. Otherwise, delete.
****

a. Stationary Mixers: For stationary mixers, before uniformity data are available, the mixing time for each batch after all solid materials are in the mixer, provided that all of the mixing water is introduced before one-fourth of the mixing time has elapsed, shall be 1 minute for mixers having a capacity of 1 cubic yard. For mixers of greater capacity, this minimum time shall be increased 20 seconds for each additional 1.33 cubic yard or fraction thereof. After results of uniformity tests are available, the mixing time may be reduced to the minimum time required to meet uniformity requirements; but if uniformity requirements are not being met, the mixing time shall be increased as directed. Mixer performance tests at new mixing times shall be performed immediately after any change in mixing time. When regular testing is performed, the concrete shall meet the limits of any five of the six uniformity requirements listed in Table 4, below. When abbreviated testing is performed, the concrete shall meet only those requirements listed for abbreviated testing. The concrete proportions used for uniformity tests shall be as used on the project. Regular testing shall consist of performing all six tests on three batches of concrete. The range for regular testing shall be the average of the ranges of the three batches. Abbreviated testing shall consist of performing the three required tests on a single batch of concrete. The range for abbreviated testing shall be the range for one batch. If more than one mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, etc., the results of tests on one of the mixers shall apply to the others, subject to the approval of the Contracting Officer. All mixer performance (uniformity) testing shall be performed by the Contractor in accordance with COE CRD-C 55 and with paragraph titled TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL.

TABLE 4
UNIFORMITY REQUIREMENTS--STATIONARY MIXERS

Parameter	Regular Tests Allowable Maximum Range for Average of 3 Batches	Abbreviated Tests Allowable Maximum Range for 1 Batch
Unit weight of air-free mortar, lb/cubic ft	2.0	2.0
Air content, percent	1.0	--
Slump, inches	25	--
Coarse aggregate, percent	6.0	6.0
Compressive strength at 7 days, percent	10.0	10.0

TABLE 4
UNIFORMITY REQUIREMENTS--STATIONARY MIXERS

Parameter	Regular Tests Allowable Maximum Range for Average of 3 Batches	Abbreviated Tests Allowable Maximum Range for 1 Batch
Water content, percent	1.5	--

b. Truck Mixers: Mixer performance (uniformity) tests for truck mixers shall be made by the Contractor in accordance with ASTM C 94.

1.14.3 Transporting Equipment

****

NOTE: Retain bracketed phrase permitting truck mixers only if truck mixers are permitted by paragraph Concrete Mixers above.

****

Concrete shall be transported to the paving site in nonagitating equipment conforming to ASTM C 94 [in approved truck mixers designed with extra large blading and rear opening specifically for low slump concrete] or in approved agitators. All transporting equipment shall be designed and operated to deliver and discharge the required concrete mixture completely without segregation.

1.14.4 Transfer and Spreading Equipment

****

NOTE: Retain the bracketed portion for large airfield paving projects. Otherwise, delete. Be sure this correlates with requirements in PART 3.

****

Equipment for transferring concrete from the transporting equipment to the paving lane in front of the paver shall be specially manufactured, self-propelled transfer equipment which will accept the concrete outside the paving lane and will transfer and spread it evenly across the paving lane in front of the paver and strike off the surface evenly to a depth which permits the paver to operate efficiently. [The travelling surge hopper shall be a specially manufactured, self-propelled transfer-placer which will operate in front of the paver and accept the concrete from the transporting equipment outside the paving lane, store it as necessary, and feed it out evenly across the lane in front of the paver at a depth which permits the paver to operate efficiently. The capacity shall be such that concrete is always available in front of the paver, to prevent the need for stopping the paver. It shall be designed to always discharge the oldest concrete remaining in the hopper before the fresher concrete.]

1.14.5 Paver-Finisher

The paver-finisher shall be a heavy-duty, self-propelled machine designed specifically for paving and finishing high quality pavement. The paver-finisher shall weigh at least 2200 lb. per footof lane width, and shall be powered by an engine having at least 6.0 horsepower per foot of lane width. The paver-finisher shall spread, consolidate, and shape the plastic concrete to the desired cross section in one pass. The mechanisms for forming the pavement shall be easily adjustable in width and thickness and for required crown. In addition to other spreaders required by paragraph Transfer and Spreading Equipment, the paver-finisher shall be equipped with a full width knock-down auger or paddle mechanism, capable of operating in both directions, which will evenly spread the fresh concrete in front of the screed or extrusion plate. Immersion vibrators shall be gang mounted at the front of the paver on a frame equipped with suitable controls so that all vibrators can be operated at any desired depth within the slab or completely withdrawn from the concrete, as required. The vibrators shall be automatically controlled so that they will be immediately stopped as forward motion of the paver ceases. The spacing of the immersion vibrators across the paving lane shall be as necessary to properly consolidate the concrete, but the clear distance between vibrators shall not exceed 30 inches. Spud vibrators shall operate at a frequency of not less than 8000 impulses per minute and an amplitude of not less than 0.03 inch and tube vibrators at a frequency of not less than 5000 impulses per minute and an amplitude of not less than 0.03 inch, as determined by COE CRD-C 521. The paver-finisher shall be equipped with a transversely oscillating screed or an extrusion plate to shape, compact, and smooth the surface and shall so finish the surface that no significant amount of hand finishing, except use of cutting straightedges, is required. The screed or extrusion plate shall be constructed to provide adjustment for crown in the pavement. The entire machine shall provide adjustment for variation in lane width or thickness and to prevent more than 8 inches of the screed or extrusion plate extending over previously placed concrete on either end when paving fill-in lanes. Machines that cause displacement of properly installed forms or cause ruts or indentations in the prepared underlying materials and machines that cause frequent delays due to mechanical failures shall be replaced as directed.

1.14.5.1 Paver-Finisher with Fixed Forms

The paver-finisher shall be equipped with wheels designed to keep it aligned with the forms and to spread the load so as to prevent deformation of the forms.

1.14.5.2 Slipform Paver-Finisher

The slipform paver-finisher shall be automatically controlled and crawler mounted with four padded tracks so as to be completely stable under all operating conditions. The paver-finisher shall finish the surface and edges so that no edge slump beyond allowable tolerance occurs. Horizontal alignment shall be electronically referenced to a taut wire guideline. Vertical alignment shall be electronically referenced on both sides of the paver to a taut wire guideline, to an approved laser control system, or, only where permitted by paragraph Slipform Paving, to a ski operating on a completed lane. Suitable moving side forms shall be provided that are adjustable and will produce smooth, even edges, perpendicular to the top surface and meeting specification requirements for alignment and freedom from edge slump.

1.14.5.3 Longitudinal Mechanical Float

A longitudinal mechanical float shall be specially designed and manufactured to smooth and finish the pavement surface without working excess paste to the surface. It shall be rigidly attached to the rear of the paver-finisher or to a separate self-propelled frame spanning the paving lane. The float plate shall be at least 5 feet long by 8 inches wide and shall automatically be oscillated in the longitudinal direction while slowly moving from edge to edge of the paving lane, with the float plate in contact with the surface at all times.

1.14.5.4 Nonrotating Pipe Float

A pipe float if used, shall be a nonrotating pipe 6 to 10 inches in diameter and sufficiently long to span the full paving width when oriented at an angle of approximately 60 degrees with the centerline. The pipe float shall be mounted on a self-propelled frame that spans the paving lane. No means of applying water to the surface shall be incorporated in the pipe float.

1.14.5.5 Other Types of Finishing Equipment

Clary screeds or other rotating tube floats, or bridge deck finishers, shall not be allowed on the project. Concrete finishing equipment of types other than specified above may be demonstrated on a test section outside the production pavement if approved in writing. If the Contracting Officer's representative decides from evaluation of the test section that the equipment is better than the specified finishing equipment, its use will be permitted as long as it continues to perform better than the specified equipment.

1.14.6 Curing Equipment

Equipment for applying membrane-forming curing compound shall be mounted on a self-propelled frame that spans the paving lane. The reservoir for curing compound shall be constantly mechanically (not air) agitated during operation and shall contain means for completely draining the reservoir. The spraying system shall consist of a mechanically powered pump which will maintain constant pressure during operation, an operable pressure gauge, and either a series of spray nozzles evenly spaced across the lane to give uniformly overlapping coverage or a single spray nozzle which is mounted on a carriage which automatically traverses the lane width at a speed correlated with the forward movement of the overall frame. All spray nozzles shall be protected with wind screens. Any hand-operated sprayers allowed by paragraph Membrane Curing shall be compressed air supplied by a mechanical air compressor. If the curing machine fails to apply an even coating of compound at the specified rate, it shall immediately be replaced.

1.14.7 Texturing Equipment

****

NOTE: Edit the following paragraphs to correlate with the drawings and with paragraph Texturing. Do not specify artificial turf drag for Air Force projects.

****

Texturing equipment shall be as specified below. Before use, the texturing equipment shall be demonstrated on a test section, and the equipment shall be modified as necessary to produce the texture directed.

1.14.7.1 Fabric Drag

A fabric drag shall consist of a piece of material as long as the lane width securely attached to a separate wheel mounted frame spanning the paving lane or to one of the other similar pieces of equipment. Width of the material shall provide 12 to 18 inches dragging flat on the pavement surface. Length shall be at least equal to the width of the slab plus 24 inches. [The material shall be clean, reasonably new burlap, completely saturated with water before attachment to the frame and always resaturated before start of use and kept clean and saturated during use. Burlap shall conform to AASHTO M 182, Class 3 or 4.] [The fabric material shall be an approved artificial turf fabricated of a plastic material, and shall be a type that has proved satisfactory for this use in previous pavement construction.]

1.14.7.2 Deep Texturing Equipment

Texturing equipment shall consist of [a stiff bristled broom] [a comb with spring wire tines] [spring strips which will produce true, even grooves] forming a drag at least 4 feet long. This drag shall be mounted in a wheeled frame spanning the paving lane and so constructed that the drag is mechanically pulled in a straight line across the paving lane perpendicular to the centerline.

1.14.8 Sawing Equipment

****

NOTE: Retain bracketed sentence as necessary to correlate with paragraph Removal of Existing Pavement Slab. Otherwise delete.

****

Equipment for sawing joints and for other similar sawing of concrete shall be standard diamond-type concrete saws mounted on a wheeled chassis which can be easily guided to follow the required alignment. Blades shall be diamond tipped. If demonstrated to operate properly, abrasive blades may be used. [Wheel saws shall be saws with large diameter tungsten carbide tipped blades mounted on a heavy-duty chassis which will produce a saw kerf at least 1-1/2 inch wide.] All saws shall be capable of sawing to the full depth required.

1.14.9 Straightedge

The Contractor shall furnish and maintain at the job site, in good condition, one 12 foot straightedge for each paving train for testing the hardened portland cement concrete surfaces. These straightedges shall be constructed of aluminum or magnesium alloy and shall have blades of box or box-girder cross section with flat bottom, adequately reinforced to insure rigidity and accuracy. Straightedges shall have handles for operation on the pavement.

1.14.10 Profilograph

****

NOTE: Retain this paragraph if paragraph Surface Smoothness bases acceptance on profilograph testing.

****

The Contractor shall furnish a 25 foot profilograph for testing the finished pavement surface. The profilograph shall produce a record on tape of the results of testing the pavement surface and shall automatically mark the Profile Index of each section tested as well as indicate and measure each "must grind" point, all in accordance with CDT Test 526 and as required by paragraph Surface Smoothness.

PART 2 PRODUCTS

****

NOTE: Delete any reference to any products which are not to be used on the project.

****

2.1 CEMENTITIOUS MATERIALS

****

NOTE: Edit these paragraphs as appropriate for the particular project. EPA regulations require that fly ash be permitted for optional use by the Contractor on all Federal projects. Specify low-alkali cement and the optional limits on alkalies in fly ash in any area where there is a chance that alkali-silica reactive aggregates might be furnished. When sulfate bearing soil or water is encountered, specify Type II cement for moderate sulfate concentration and Type V cement for high concentration and consider requiring use of fly ash or GGBF slag for partial replacement. See EM 1110-2-2000 for guidance. Specify limit on false set if it is a problem in the area. If use of blended cement has shown good service in the area, and it is desired for this project, specify it to meet ASTM C 595, Type as considered appropriate; do not specify Type I(PM) or Type I(SM). Class F pozzolan (fly ash) should be the pozzolan normally specified; Class C pozzolan (fly ash) can be specified if it has a good service record in the area. Type III cement should not be specified unless "fast-track" paving is involved and then only after laboratory mixture proportioning studies and tests during the design stage of the project. Air-entraining cement should never be specified.

****

Cementitious materials shall be portland cement, [or portland-pozzolan cement,] [or portland blast-furnace slag cement,] or only portland cement in combination with pozzolan [or ground granulated blast furnace slag] [or silica fume] and shall conform to appropriate specifications listed below. Temperature of cementitious materials as supplied to the project shall not exceed 150 degrees F.

2.1.1 Portland Cement

Portland cement shall conform to ASTM C 150, Type [I] [II], [except that the maximum amount of C3A in Type I cement shall be 15 percent] [low-alkali] [including false set requirements]. [Portland cement shall conform to ASTM C 150 Type V, low-alkali].

2.1.2   High-Early-Strength Portland Cement

****
NOTE: Use only where "fast-track" paving is required. Fill in blank.
****

High-early-strength cement shall conform to ASTM C 150, Type III with C3A limited to [5] [8] percent, [low-alkali]. Type III cement shall be used only in concrete in the following locations [_____].

2.1.3   Blended Cements

****
NOTE: Use only in areas where each blended cement has a good service record. Edit as appropriate.
****

Blended cement shall conform to ASTM C 595, Type [IP] [IP (MS)] [IS] [IS (MS)].

2.1.4   Pozzolan (Fly Ash and Silica Fume)

2.1.4.1   Fly Ash

****
NOTE: If fly ash is used, it normally shall be used only at the rate between 15 and 35 percent by mass of the total cementitious material. Use the bracketed limit on alkalies whenever low-alkali cement is specified. See NOTE for Pargraph MIXTURE PROPORTIONS BY CONTRACTOR, for guidance in areas of severe alkali-aggregate problems.
****

Fly ash shall conform to ASTM C 618, Class [C] [F], with the optional requirements for multiple factor, drying shrinkage, and uniformity from Table 2A in ASTM C 618. The fly ash shall meet the optional [requirements on limits of alkalies in Table IA of ASTM C 618] [limit on mortar expansion from Table IIA of ASTM C 618]. Fly ash shall be used only at a rate between 15 and 35 percent of the total cementitious material by mass.

2.1.4.2   Silica Fume

Silica fume shall conform to ASTM C 1240; available alkalies shall conform to the optimal limit given in Table 2. Silica fume may be furnished as a dry, densified material or as a slurry. [The Contractor shall provide at his expense the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume. This representative shall be present on the project prior to and during at least the first 4 days of concreting using silica fume.]

2.1.5   Ground Granulated Blast-Furnace (GGBF) Slag

Ground Granulated Blast-Furnace Slag shall conform to ASTM C 989, Grade 120.

2.2   AGGREGATES

****

NOTE: The designer will ensure that aggregates available in the area meet the requirements of these specifications. Otherwise, the specification requirements must be modified to allow use of available material. This concern must be discussed and validated in the Design Analysis before preparation of the project specifications. During the design stage, the designer must assure that all aggregate materials in the area which meet the project specifications will also produce concrete of the specified flexural strength with a reasonable cementitious material content. Otherwise, specifications and design assumptions must be modified. It is imperative that all aggregate be investigated for problems related to alkali-aggregate reactions.

Special attention should be given to aggregates to be used for compass calibration pads. Aggregates with magnetic properties, such as, but not limited to, magnetite in granites, high-iron minerals in traprock, pyrite in limestone, and free iron or iron oxide in slag aggregate should not be used. When the paving of compass calibration pads is required, include, add to, and edit the bracketed item concerning compass pads as additional requirements for coarse and fine aggregates.

For Air Force projects add the bracketed statements.

****

[In addition to the grading requirements specified for coarse aggregate and for fine aggregate, the combined aggregate grading shall meet the following requirements.

a. If necessary, a blending aggregate shall be used to meet the required combined grading. This blending aggregate shall be batched separately. The combined grading of all aggregates used, in the proportions selected, shall be computed on the basis of cumulative percent retained on each sieve specified for fine and coarse aggregate.

b. The materials selected and the proportions used shall be such that when the Coarseness Factor (CF) and the Workability Factor (W) are plotted on a diagram as described in d. below, the point thus determined shall fall within the parallelogram described therein.

c. The Coarseness Factor (CF) shall be determined from the following equation:

CF = (cumulative percent retained on the 3/8 in. sieve)(100)/(cumulative percent retained on the No. 8 sieve)

The Workability Factor (W) is defined as the cumulative percent passing the No. 8 sieve. However, W shall be adjusted, upwards only, by 2.5 percentage points for each 94 pounds of cementitious material per cubic yard greater than 564 pounds per cubic yard.

d. A diagram shall be plotted using a rectangular scale with W on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram a parallelogram shall be plotted with corners at the following coordinates (CF-75, W-28), (CF-75, W-40), (CF-45, W-32.5), and (CF-45, W-41). If the point determined by the intersection of the computed CF and W does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected shall be changed as necessary.

e. In addition, the individual percent retained on each sieve shall be plotted for the combined aggregate grading, on either rectangular or semi-log graph paper. The graph shall show a relative smooth transition between coarse and fine aggregate and shall have no major valleys or peaks in the area smaller than the No. 8 sieve. If this plot does not meet the above criteria, the grading of each size aggregate used and the proportions selected shall be changed as necessary.]

2.2.1 Coarse Aggregate

Coarse aggregate shall have a satisfactory service record of at least 5 years successful service in three paving projects or, if a new source is used, shall meet the requirements when tested for resistance to freezing and thawing.

2.2.1.1 Material Composition

****

NOTE: Crushing gravel tends to improve quality and bond characteristics and generally results in higher flexural strength of concrete. When mixture proportioning studies or local experience indicates that low flexural strength concrete will be produced with an uncrushed gravel, the possibility of producing higher strength concrete by crushing the gravel should be investigated. When desirable to limit coarse aggregate to crushed materials, modify this paragraph appropriately.

Do not, under any conditions, permit use of steel furnace slag for any aggregate. (It is markedly different from iron blast furnace slag.)

In power check pads, the high temperatures from jet blast can cause distress in aggregates in the concrete. Include bracketed item if power check pads are to be constructed. If no service record is available, lab study of available aggregates should be made.

Insert bracketed item on reclaimed material only when investigations have shown such material to be available and to be suitable.
****

Coarse aggregate shall consist of [[crushed] [uncrushed] gravel], crushed stone, [crushed adequately seasoned air-cooled iron blast-furnace slag; steel furnace slag will not be permitted], [reclaimed portland cement concrete] [or a combination thereof]. [Crushed gravel shall contain not less than 75 percent of crushed particles by mass in each sieve size, as determined by COE CRD-C 171.] [Aggregate used for paving compass calibration hardstands shall be free of materials having magnetic properties.] [Coarse aggregate used for paving power check pads shall be limestone, dolomite, basalt or other approved material which will not cause thermal distress from jet blast.] [Reclaimed concrete pavement or granular base produced from required removal operations may be used for aggregate, provided it meets all requirements specified herein for aggregates.]

2.2.1.2 Quality

****
NOTE: Retain the bracketed requirement for washing coarse aggregate if aggregates in the area require it. Add the requirement to use a log washer or other specific equipment if experience in the area shows the need. Delete if not needed. It is permissible to list certain aggregate sources that do not require washing, if that is appropriate. The designer must make the decision during preparation of specifications; do not make the Resident Engineer decide after award if aggregates need to be washed.
****

Aggregates as delivered to the mixers shall consist of clean, hard, uncoated particles meeting the requirements of ASTM C 33 and other requirements specified herein. [Coarse aggregate shall be washed. Washing shall be sufficient to remove dust and other coatings.] [Coarse aggregate shall be cleaned by processing with an approved log washer.] [Iron blast-furnace slag conforming to the grading to be used in the concrete shall have a compact density of not less than 70 lb/cu. ft. determined in accordance with ASTM C 29/C 29M].

2.2.1.3 Particle Shape Characteristics

Particles of the coarse aggregate shall be generally spherical or cubical in shape. The quantity of flat and elongated particles in any size group shall not exceed 20 percent by weight as determined by COE CRD-C 119. A flat particle is defined as one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3.

2.2.1.4 Size and Grading

****
NOTE: Fill in the blank according to the size aggregate available in the project area, and the type of paving. Delete the bracketed item on thin

bonded overlays unless applicable to the project.
****

The nominal maximum size of the coarse aggregate shall be [_____] inchesand shall meet the size groups below. When the nominal maximum coarse size is greater than 1 inch, the aggregates shall be furnished in two size groups as follows:

Nominal Maximum Size Inches	Size Group
3/4	ASTM C 33 --No.67 (No. 4 to 3/4 inch)
1-1/2	ASTM C 33 --No. 4 (3/4 to 1-1/2 inch

The grading of the coarse aggregate within the separated size groups shall conform to the requirements of ASTM C 33, Sizes 67 and 4 as delivered to the mixer. [The nominal maximum size aggregate used in a thin bonded overlay shall not exceed one-third of the overlay thickness. Overlay thickness used in determining coarse aggregate size shall not include additional thickness for leveling. The entrained air content shall be increased nearer the upper limit as the maximum coarse-aggregate size is decreased.]

2.2.1.5 Deleterious Materials - Airfield Pavements

****

NOTE: In Table 5 select columns showing appropriate percentage by weight in accordance with local experience with "popouts" and the following. Delete the inapplicable columns in the table and the heading of the column used.

Weather Severity	**Air Freezing Index Coldest year in 30 (a)**	**Average Precipitation for any Single Month during the Freezing Period**
Moderate	**500 or less**	**Any Amount**
Moderate (b)	**501 or more**	**Less than 25 mm (1 inch)**
Severe	**501 or more**	**25 mm (1 inch) or more**

(a) Calculated as described in TM 5-825-2. See ASTM C 33 for simplified map of CONUS weather severity.

(b) In poorly drained areas, the weather should be considered severe even though the other criteria

indicate a rating of moderate.

"Areas with major popouts" are considered to be those where popouts have caused any problem with aircraft operations. All other areas will be considered to be "Areas with minor popouts," for all airfield pavements. Delete this paragraph only if there are no airfield pavements.

****

The amount of deleterious material in each sieve size of coarse aggregate shall not exceed the limits shown in Table 5 below, determined in accordance with the test methods shown.

TABLE 5
LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE
FOR AIRFIELD PAVEMENTS
Percentage by Mass

Materials	Areas with Major Popouts Severe Weather	Areas with Major Popouts Moderate Weather	Areas with Minor Popouts Severe Weather	Areas with Minor Popouts Moderate Weather
Clay lumps and friable particles (ASTM C 142)	0.2	0.2	2.0	2.0
Shale (a) (ASTM C 295)	0.1	0.2	1.0	1.0
Material finer than 0.075 mm (No. 200 sieve) (b) (ASTM C 117)	0.5	0.5	1.0	1.0
Lightweight particles (c) (ASTM C 123)	0.2	0.2	0.5	0.5
Clay ironstone (d) (ASTM C 295)	0.1	0.5	1.0	1.0
Chert and cherty stone (less than 2.40 Mg/cubic meter density SSD (2.40 Sp. Gr.)) (e) (ASTM C 295)	0.1	0.5	1.0	5.0
Claystone, mudstone, and siltstone (f) (ASTM C 295)	0.1	0.1	1.0	1.0
Shaly and argillaceous limestone (g) (ASTM C 295)	0.2	0.2	1.0	1.0
Other soft particles COE CRD-C 130	1.0	1.0	1.0	2.0
Total of all deleterious substances exclusive of material	1.0	2.0	3.0	5.0

TABLE 5
LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE
FOR AIRFIELD PAVEMENTS
Percentage by Mass

Materials	Areas with Major Popouts Severe Weather	Areas with Major Popouts Moderate Weather	Areas with Minor Popouts Severe Weather	Areas with Minor Popouts Moderate Weather
finer than 0.075 mm (No. 200 sieve)				

a. Shale is defined as a fine-grained, thinly laminated or fissile sedimentary rock. It is commonly composed of clay or silt or both. It has been indurated by compaction or by cementation, but not so much as to have become slate.

b. Limit for material finer than 0.075 mm (No. 200 sieve) will be increased to 1.5 percent for crushed aggregates if the fine material consists of crusher dust that is essentially free from clay or shale.

c. The separation medium shall have a density of 2.0 Mg/cubic meter (Sp. Gr. of 2.0). This limit does not apply to coarse aggregate manufactured from blast-furnace slag unless contamination is evident.

d. Clay ironstone is defined as an impure variety of iron carbonate, iron oxide, hydrous iron oxide, or combinations thereof, commonly mixed with clay, silt, or sand. It commonly occurs as dull, earthy particles, homogeneous concretionary masses, or hard-shell particles with soft interiors. Other names commonly used for clay ironstone are "chocolate bars" and limonite concretions.

e. Chert is defined as a rock composed of quartz, chalcedony or opal, or any mixture of these forms of silica. It is variable in color. The texture is so fine that the individual mineral grains are too small to be distinguished by the unaided eye. Its hardness is such that it scratches glass but is not scratched by a knife blade. It may contain impurities such as clay, carbonates, iron oxides, and other minerals. Other names commonly applied to varieties of chert are: flint, jasper, agate, onyx, hornstone, porcellanite, novaculite, sard, carnelian, plasma, bloodstone, touchstone, chrysoprase, heliotrope, and petrified wood. Cherty stone is defined as any type of rock (generally limestone) that contains chert as lenses and nodules, or irregular masses partially or completely replacing the original stone.

f. Claystone, mudstone, or siltstone, is defined as a massive fine-grained sedimentary rock that consists predominantly of indurated clay or silt without laminations or fissility. It may be indurated either by compaction or by cementation.

g. Shaly limestone is defined as limestone in which shale occurs as one or more thin beds or laminae. These laminae may be regular or very irregular and may be spaced from a few inches down to minute fractions of an inch. Argillaceous limestone is defined as a limestone in which clay minerals occur disseminated in the stone in the amount of 10 to 50 percent by weight of the rock; when these make up from 50 to 90 percent, the rock is known as calcareous (or dolomitic) shale (or claystone, mudstone, or siltstone).

2.2.1.6 Testing Sequence Deleterious Materials -- Airfields Only

****

NOTE: Insert the proper Corps of Engineers Laboratory name in the bracketed blank at the end of this paragraph.

****

The size of the sample shall be at least 200 pounds for the 3/4 to 1-1/2 inch size and 25 pounds for the No. 4 to 3/4 inch coarse aggregate and 10 pounds for the fine aggregate. The Contractor shall provide facilities for the ready procurement of representative test samples. Samples shall be taken and tested by and at the expense of the Contractor, using appropriate Corps of Engineers laboratory and ASTM test methods. Additional tests and analyses of aggregates at various stages in the processing and handling operations may be made by the Government at the discretion of the Contracting Officer. Such Government testing will not relieve the Contractor of any of its testing responsibilities. The testing procedure on each sample of coarse aggregate for compliance with limits on deleterious materials shall be as follows:

Step 1: Test approximately one-fifth of sample for material finer than the No. 200 sieve.

Step 2: Wash off material finer than No. 200 sieve from the remainder of the sample and recombine the remainder with material retained on the No. 200 sieve from Step 1.

Step 3: Test remaining full sample for clay lumps and friable particles and remove.

Step 4: Test remaining full sample for lightweight particles and remove, and then for chert and/or cherty stone with SSD density of less than 2.40 Mg/cubic meter (Sp. Gr. 2.40) and remove.

Step 5: Test remaining sample for clay-ironstone, shale, claystone, mudstone, siltstone, shaly and/or argillaceous limestone, and remove.

Step 6: Test approximately one-fifth of remaining full sample for other soft particles.

Determination of deleterious materials listed in Steps 4 and 5 shall be performed by an individual specifically trained in petrographic identification. The individual selected to perform the identification of these deleterious materials shall be subject to approval and, at least 10 days before any individual is proposed to commence this type of work, the Contractor shall submit a written r,sum, of the individual's training and experience for approval by the [_____] Laboratory. The Contractor will not be entitled to any extension of time or additional payment due to any delays caused by the testing, evaluation, or personnel requirements.

2.2.1.7 Resistance to Freezing and Thawing

Coarse aggregate not having a satisfactory demonstrable service record shall have a durability factor of 50 or more when subjected to freezing and thawing in concrete in accordance with COE CRD-C 114.

2.2.1.8 Resistance to Abrasion

Coarse aggregate shall not show more than 40 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C 131.

2.2.1.9 Deleterious Material-Road Pavements

****

NOTE: Use this paragraph only for roads, streets, and parking lots for vehicular and tracked traffic. Otherwise, delete.

****

The amount of deleterious material in each sieve size of coarse aggregate shall not exceed the limits in the following table when tested as indicated.

LIMITS OF DELETERIOUS MATERIALS IN COARSE
AGGREGATE FOR ROAD PAVEMENTS
Percentage by Mass

Clay lumps and friable particles (ASTM C 142)	2.0
Material finer than 0.075 mm (No. 200 sieve) (ASTM C 117)	1.0
Lightweight particles (ASTM C 123)	1.0
Other soft particles (ASTM C 330)	2.0

The total of all deleterious substances shall not exceed 5.0 percent of the mass of the aggregate. The percentage of material finer than the No. 200 sieve shall not be included in this total. The limit for material finer than the No. 200 sieve will be increased to 1.5 percent for crushed aggregates consisting of crusher dust that is essentially free from clay or shale. The separation medium for lightweight particles shall have a density of 2.0 Mg/cubic meter (Sp. Gr. 2.0). This limit does not apply to coarse aggregate manufactured from blast-furnace slag unless contamination is evident.

2.2.2 Fine Aggregate

Fine aggregate shall have a service record of at least 5 years satisfactory service in three paving projects or, if a new source is used, shall meet the requirements for resistance to freezing and thawing.

2.2.2.1 Composition

****

NOTE: If reclaimed portland cement concrete is

permitted, retain the bracketed portion regarding reclaimed PCC; otherwise, delete. If reclaimed PCC is permitted to be used, laboratory studies must be performed during the design stage to validate mixture proportions and to evaluate relative durability of the concrete produced.
****

Fine aggregate shall consist of natural sand, manufactured sand, or a combination of the two, and shall be composed of clean, hard, durable particles. [Aggregate used for paving compass calibration hardstands shall be free of materials having magnetic properties.] [Fine aggregate shall consist of the minus 3/8 inch material from the reclaimed portland cement concrete or a combination of the crushed reclaimed concrete blended with sand. If insufficient fine aggregate is available from the recycling process, the additional material shall be natural sand, manufactured sand or a combination thereof meeting all requirements specified.] Irrespective of the source from which it is obtained, all fine aggregate shall be composed of clean, hard, durable particles meeting the requirements of ASTM C 33. Each type of fine aggregate shall be stockpiled and batched separately. Any degree of contamination will be cause for the rejection of the entire stockpile.

2.2.2.2 Particle Shape

Particles of the fine aggregate shall be generally spherical or cubical in shape.

2.2.2.3 Grading

Grading of the fine aggregate, as delivered to the mixer, shall conform to the requirements of ASTM C 33. In addition, the fine aggregate, as delivered to the mixer, shall have a fineness modulus of not less than 2.50 nor more than 3.00. The grading of the fine aggregate also shall be controlled so that the fineness moduli of at least nine of every set of ten consecutive samples of the fine aggregate, as delivered to the mixer, will not vary more than 0.15 from the average fineness moduli of all samples previously taken. The fineness modulus shall be determined by COE CRD-C 104.

2.2.2.4 Deleterious Material

The amount of deleterious material in the fine aggregate shall not exceed the following limits by mass:

Material	Percentage by Mass
Clay lumps and friable particles ASTM C 142	1.0
Material finer than 0.075 mm (No. 200 sieve) ASTM C 117	3.0
Lightweight particles ASTM C 123 using a medium with a density of 2.0 Mg/cubic meter (Sp. Gr. of 2.0))	0.5
Total of all above	3.0

2.2.2.5 Resistance to Freezing and Thawing

Fine aggregate not having a satisfactory demonstrable service record shall have a durability factor of 50 or more when subjected to freezing and thawing in concrete in accordance with COE CRD-C 114.

2.3 CHEMICAL ADMIXTURES

2.3.1 Air-Entraining Admixtures

The air-entraining admixture shall conform to ASTM C 260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entraining admixture shall be in a solution of suitable concentration for field use.

2.3.2 Accelerator

An accelerator shall be used only when specified in paragraph SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES and shall not be used to reduce the amount of cementitious material used. Accelerator shall conform to ASTM C 494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

2.3.3 Retarder

A retarding admixture shall meet the requirements of ASTM C 494, Type B, except that the 6-month and 1-year compressive strength tests are waived. The use of the admixture is at the option of the Contractor, but shall not be used to reduce the amount of cementitious material.

2.3.4 Water-Reducer

A water-reducing admixture shall meet the requirements of ASTM C 494, Type A or D except that the 6-month and 1-year compressive strength tests are waived. The admixture may be added to the concrete mixture only when its use is approved or directed, and only when it has been used in mixture proportioning studies to arrive at approved mixture proportions.

2.4 CURING MATERIALS

2.4.1 Membrane Forming Curing Compound

Membrane forming curing compound shall be a white pigmented compound conforming to COE CRD-C 300.

2.4.2 Burlap

Burlap used for curing shall conform to AASHTO M 182, Class 3 or 4. Materials shall be new or shall be clean materials never used for anything other than curing concrete.

2.4.3 Impervious Sheet Materials

****
NOTE: Edit this paragraph to allow or disallow polyethylene film.
****

Impervious sheet materials shall conform to ASTM C 171, type optional, except [polyethylene sheet shall be white opaque] [polyethylene sheet shall not be used].

2.5 WATER

Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water may be used if it meets the requirements of COE CRD-C 400.

2.6 JOINT MATERIALS

****

NOTE: Edit as appropriate for project requirements. Expansion joint filler material must be compatible with joint sealer specified. Do not use bituminous joint filler if joint sealer is non-bituminous. For slip joints select one bracketed item or remove both brackets and let it be the Contractor's option.

****

2.6.1 Expansion Joint Material

Expansion joint filler shall be a preformed material conforming to [ASTM D 1751 or] [ASTM D 1752 Type [I] [II] [III].] Expansion joint filler shall be 3/4 inch thick.

2.6.2 Slip Joint Material

Slip joint material shall be [1/4 inch thick expansion joint filler conforming to ASTM D 1751 or ASTM D 1752] or [a low penetration grade (40 to 50, or 60 to 70) asphalt cement, ASTM D 946 or a clay-type asphalt-base emulsion similar to that used for roof coating, ASTM D 1227, or Type B asphalt meeting ASTM D 449].

2.6.3 Contraction Joint Inserts

****

NOTE: Retain this paragraph only if contraction joint inserts are to be permitted. Delete bracketed item about nonsawable inserts if they are not to be permitted.

****

Sawable contraction joint inserts shall conform to COE CRD-C 540. [Nonsawable contraction joint inserts shall have sufficient stiffness to permit placement in plastic concrete without deviation from a straight line and shall conform to the physical requirements of COE CRD-C 540, with the exception of Section 4.4, "Resistance to Sawing." Material for polyvinyl chloride inserts shall conform to COE CRD-C 572.] Metal inserts shall not be used.

2.7 REINFORCING

****

NOTE: Edit these paragraphs to conform to project requirements. Delete those not needed. Add epoxy-coated bars (ASTM A 775) or low-alloy bars (ASTM A 706) when required by design.

****

All reinforcement shall be free from loose, flaky rust, loose scale, oil, grease, mud, or other coatings that might reduce the bond with concrete. Removal of thin powdery rust and tight rust is not required. However, reinforcing steel which is rusted to the extent that it does not conform to the required dimensions or mechanical properties shall not be used.

2.7.1 Reinforcing Bars and Bar Mats

Reinforcing bars shall conform to [ASTM A 615/A 615M, billet-steel] [ASTM A 616/A 616M, rail-steel] [ASTM A 617/A 617M, axle-steel], Grade [_____]. Bar mats shall conform to ASTM A 184/A 184M. The bar members shall be [billet] [rail] [axle] steel.

2.7.2 Welded Wire Fabric

Welded steel wire fabric shall conform to ASTM A 185.

2.7.3 Deformed Wire Fabric

Welded deformed steel wire fabric shall conform to ASTM A 497.

2.7.4 Steel Fiber Reinforcing

Minimum ultimate tensile strength of the fibers shall be 50,000 psi. The maximum aspect ratio (length divided by diameter) shall not exceed 100. Fibers longer than 2-1/2 inches shall not be used without approval of the Contracting Officer. The fibers shall be deformed and shall be furnished in small bundles adhered with water soluble glue. The fibers shall be clean and free of rust, oil, and deleterious materials.

2.8 DOWELS AND TIE BARS

****

NOTE: Retain paragraph on dowels if design requires dowels or if they are optional. Even if not required, design should normally allow dowels as an option. Edit tie bars as required by design.

****

2.8.1 Dowels

Dowels shall be single piece bars fabricated or cut to length at the shop or mill before delivery to the site. Dowels shall be free of loose, flaky rust and loose scale and shall be clean and straight. Dowels may be sheared to length provided that the deformation from true shape caused by shearing does not exceed 0.04 inch on the diameter of the dowel and does not extend more than 0.04 inch from the end of the dowel. Dowels shall be plain (non-deformed) steel bars conforming to ASTM A 615/A 615M, Grade 40 or 60; ASTM A 616/A 616M, Grade 50 or 60; or ASTM A 617/A 617M, Grade 40 or 60; or shall be steel pipe conforming to ASTM A 53, extra strong, as indicated. If split dowels are proposed for use, a complete description of the materials and installation procedures shall be submitted for approval at least 15 days before start of construction. Paint for dowels shall conform to SSPC Paint 5; SSPC Paint 25; or FS TT-P-645.

2.8.2 Tie Bars

Tie bars shall be deformed steel bars conforming to ASTM A 615/A 615M, ASTM A 616/A 616M, or ASTM A 617/A 617M, Grade [_____], and of the sizes and dimensions indicated. Deformed rail steel bars and high-strength billet or axle steel bars, Grade 60 or higher, shall not be used for bars that are bent and straightened during construction.

2.9   EPOXY RESIN

All epoxy-resin materials shall be two-component materials conforming to the requirements of ASTM C 881, Class as appropriate for each application temperature to be encountered, except that in addition, the materials shall meet the following requirements:

a. Material for use for embedding dowels and anchor bolts shall be Type IV, Grade 3.

b. Material for use as patching materials for complete filling of spalls, wide cracks, and other voids and for use in preparing epoxy resin mortar shall be Type III, Grade as approved.

c. Material for use for injecting cracks shall be Type IV, Grade 1.

d. Material for bonding freshly mixed portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete shall be Type V, Grade as approved.

2.10   SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES

****
NOTE: Fill in blanks as appropriate. Specified strength must be the flexural strength used in the structural design of the pavement. Designer must also ensure that this strength is attainable with the available aggregates, without excessive cement content. Maximum water-cementitious material ratio should be 0.45 for severe or moderate climate and 0.50 for mild climate with little or no snow or frost. (See EM 1110-2-2000 for more detailed guidance.) Air content should be specified as 6 percent where freezing and thawing is a concern and 5 percent where it is not a concern. Specify strength at 90 days. However, modify to 28-days in line 2 if 28-day strength is used in paragraph, Flexural Strength and Thickness. Be sure this and succeeding paragraphs correlate.
****

2.10.1   Specified Flexural Strength

Specified flexural strength, R, for concrete is [_____] psi at 90 days, as determined by tests made in accordance with ASTM C 78 of beams fabricated and cured in accordance with ASTM C 192/C 192M or as determined by equivalent flexural strength for acceptance as specified in paragraph, Flexural Strength. Maximum allowable water-cementitious material ratio is [0.45] [0.50]. The water-cementitious material ratio will be the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus pozzolan, silica fume, and ground granulated blast furnace slag by the mass equivalency method described in ACI 211.1. The concrete shall be air-entrained with a total air content of [_____] plus or minus 1.5 percentage points, at the point of placement. Air content shall be determined in accordance with ASTM C 231. The maximum allowable slump of the concrete at the point of placement shall be 2 inches for pavement constructed with fixed forms. For slipformed pavement, at the start of the project, the Contractor shall select a maximum allowable slump which will produce in-place pavement meeting the specified tolerances for control of edge slump.

2.10.2 Concrete Temperature

The temperature of the concrete as delivered shall conform to the requirements of paragraphs, Paving in Hot Weather and Paving in Cold Weather. Temperature of concrete shall be determined in accordance with ASTM C 1064.

2.10.3 Concrete Strength for Final Acceptance

The strength of the concrete will be considered acceptable when the average equivalent [90-day] [28-day] Flexural strengths for each lot are above the'Specified Flexural Strength' as determined by correlation with 14-day compressive strength tests specified in paragraph MIXTURE PROPORTIONS BY CONTRACTOR for [90-day] [28-day] flexural Strength, and no individual set (2 cylinders per sublot) in the lot are 25 psi or more below the equivalent 'Specified Flexural Strength'. If any lot or sublot, respectively, fails to meet the above criteria, the lot or sublot shall be removed and replaced at no additional cost to the Government. This is in addition to and does not replace the average strength required for day-to-day CQC operations as specified in paragraph Average Flexural Strength Required for Mixtures.

2.11 MIXTURE PROPORTIONS BY CONTRACTOR

****

NOTE: This paragraph places the responsibility for mixture proportioning on the Contractor. Where Government mix design is required, this paragraph will be deleted. Edit bracketed items as appropriate. Normally, permit accelerator only with fast-track paving. If approval has been obtained and airfield pavement has been designed and specified for 28-day flexural strength in paragraph Flexural Strength and Thickness, modify the following subparagraphs accordingly. Do the same if this is road pavement designed for 28-day strength. Use the higher bracketed cement content if pozzolan is used. For projects in areas where alkiali-aggregate reaction is a serious problem, contact the TSMCX for guidance--important.

****

2.11.1 Composition

Concrete shall be composed of cementitious material, water, fine and coarse aggregates, and admixtures. The cementitious material shall be portland cement, [or blended cement]; [or only portland cement in combination with [pozzolan], [ground granulated blast-furnace slag], [silica fume]]. Pozzolan, if used, shall consist of not less than 15 percent of the cementitious material by mass and not more than 35 percent. The total cementitious material content shall be at least [470 lb./cu. yd.] [517 lb./cu. yd.]. Admixtures shall consist of air entraining admixture [and shall also include] [and may also include, as approved] [accelerator] [retarder] [water-reducing admixture. If water-reducer is used, it shall be used only at the dosage determined during mixture proportioning studies.] High range water-reducing admixtures and admixtures to produce flowable concrete shall not be used.

2.11.2 Concrete Proportioning Studies, Pavement Concrete

Trial design batches, mixture proportioning studies, and testing requirements shall be the responsibility of the Contractor. Mixture proportioning studies shall be performed by a commercial laboratory, inspected by the Government, and approved in writing. The laboratory performing the mixture proportioning shall conform with ASTM C 1077. Strength requirements during mixture proportioning studies shall be based on flexural strength as determined by test specimens fabricated in accordance with ASTM C 192/C 192M and tested in accordance with ASTM C 78. Samples of all materials used in mixture proportioning studies shall be representative of those proposed for use on the project and shall be accompanied by the manufacturer's or producer's test reports indicating compliance with these specifications. Trial mixtures having proportions, slumps, and air content suitable for the work shall be based on methodology described in ACI 211.1, modified as necessary to accommodate flexural strength.

2.11.2.1 Water-Cement Ratio

At least three different water-cement ratios, which will produce a range of strength encompassing that required on the project, shall be used. The maximum allowable water-cement ratio required in paragraph Maximum Water-Cement Ratio will be the equivalent water-cement ratio as determined by conversion from the mass ratio of water to cement plus pozzolan, silica fume, and ground granulated blast furnace (GGBF) slag by the weight equivalency method as described in ACI 211.1. In the case where silica fume or GGBF slag is used, the mass of the silica fume and GGBF slag shall be included in the equations in ACI 211.1 for the term P, which is used to denote the mass of pozzolan. If pozzolan is used in the concrete mixture, the minimum pozzolan content shall be 15 percent by mass of the total cementitious material, and the maximum shall be 35 percent. Laboratory trial mixtures shall be proportioned for maximum permitted slump and air content.

2.11.2.2 Trial Mixture Studies

Separate sets of trial mixture studies shall be made for each combination of cementitious materials and each combination of admixtures proposed for use. No combination of either shall be used until proven by such studies, except that, if approved in writing and otherwise permitted by these specifications, an accelerator or a retarder may be used without separate trial mixture study. Separate trial mixture studies shall also be made for concrete for any placing method proposed which requires special properties. The temperature of concrete in each trial batch shall be reported. Each mixture shall be designed to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding. Concrete proportioning studies shall be performed using the following procedures:

2.11.2.3 Mixture Proportioning for 90-day Flexural Strength

The following step by step procedure shall be followed:

a. Fabricate all beams and cylinders for each mixture from the same batch or blend of batches. Fabricate and cure all beams and cylinders in accordance with ASTM C 192/C 192M, using 6 x 6 inch beams and 6 x 12 inch cylinders.

b. Test beams in accordance with ASTM C 78, cylinders in accordance with ASTM C 39.

c. Fabricate and cure test beams from each mixture for 7, 14, 28 and 90-day flexural tests; 6 beams to be tested per age.

d. Fabricate and cure test cylinders from each mixture for 7, 14, 28 and 90-day compressive strength tests; 6 cylinders to be tested per age.

e. Using the average strength for each w/c at each age, plot all results from each of the three mixtures on separate graphs for w/c versus:

   7-day flexural strength
   14-day flexural strength
   28-day flexural strength
   90-day flexural strength

   7-day compressive strength
   14-day compressive strength
   28-day compressive strength
   90-day compressive strength

f. From these graphs select a w/c that will produce a mixture giving a 90-day flexural strength equal to the required strength determined in accordance with paragraph "Average Flexural Strength Required for Mixtures".

g. Using the above selected w/c, select from the graphs the expected 7, 14, 28 and 90-day flexural strengths and the expected 7, 14, 28 and 90-day compressive strengths for the mixture.

h. From the above expected strengths for the selected mixture determine the following Correlation Ratios:

   (1) Ratio of the 14-day compressive strength of the selected mixture to the 90-day flexural strength of the mixture (for acceptance).

   (2) Ratio of the 7-day compressive strength of the selected mixture to the 90-day flexural strength of the mixture (for CQC control).

i. If there is a change in materials, additional mixture design studies shall be made using the new materials and new Correlation Ratios shall be determined.

j. No concrete pavement shall be placed until the Contracting Officer has approved the Contractor's mixture proportions.

2.11.3 Contractor Quality Control for Average Flexural Strength

The Contractor's day to day production shall be Controlled (CQC) in accordance with the criteria herein, in the following subparagraphs, and in par. 'Concrete Strength Testing for CQC'. This is entirely different from the acceptance requirements of par. 'Concrete Strength for Final Acceptance', and it is mandatory that both sets of requirements must be met. If at any time, the 'equivalent average 90-day flextural strength', for any lot, as determined by correlation with results of 7-day compressive test specimens, is 69 psi or more below the 'required equivalent average 90-day flexural strength', as specified below, the paving operation shall be stopped and the Contractor shall take necessary steps to improve the mixture proportioning, materials, or the batching and mixing to increase the strength. The paving operations shall not recommence until the Contracting Officer has approved the Contractor's Proposed changes in writing.

2.11.3.1 Average CQC Flexural Strength Required for Mixtures

In order to ensure meeting, the strength requirements specified in paragraph SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES, during production, the mixture proportions selected during mixture proportioning studies and used during construction shall produce a required average CQC flexural strength exceeding the specified strength, R, by the amount indicated below. This required average CQC flexural strength, Ra, will be used only for CQC operations as specified in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL and as specified in the previous paragraph. During production, the required Ra shall be adjusted (increased or decreased), as appropriate and as approved, based on the standard deviation of equivalent 90-day strengths being attained during paving.

a. From Previous Test Records: Where a concrete production facility has previous test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 214.3R. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected, shall represent concrete produced to meet a specified flexural strength or strengths within 150 psi of the 90-day flexural strength specified for the proposed work, and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two specimens made from the same sample of concrete and tested at 90 days. Required average CQC flexural strength, Ra, used as the basis for selection of concrete proportions shall be the value from the equation that follows, using the standard deviation as determined above:

$$Ra = R + 1.34S$$

Where: S = standard deviation
R = specified flexural strength
Ra = required average flexural strength

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and a modification factor from the following table:

NUMBER OF TESTS	MODIFICATION FACTOR FOR STANDARD DEVIATION
15	1.16
20	1.08
25	1.03
30 or more	1.00

b. Without Previous Test Records: When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, the required average strength, Ra, shall be determined by adding 15 percent to the specified flexural strength, R.

2.12 MIXTURE PROPORTIONS BY GOVERNMENT

****

NOTE: If Government mix proportioning is desired, use this paragraph in lieu of paragraph MIXTURE PROPORTIONS BY CONTRACTOR and its subparagraphs. Edit bracketed items as appropriate. Normally, permit or require accelerator only with fast-track paving. If water reducing admixture is required, be sure it is included under paragraph MEASUREMENT AND PAYMENT.

****

The Government will provide concrete mixture proportions to be used for all concrete pavement. Field adjustments will be made by the Government as necessary. The Contractor shall be responsible for field adjustments of water and air-entraining admixture to meet specification requirements. Concrete shall be composed of cementitious material, water, fine and coarse aggregate, and admixtures. The cementitious material shall be portland cement, [or blended cement] [or portland cement only, in combination with [pozzolan], [GGBF slag], [silica fume]]. Pozzolan if used, shall consist of not less than 15 percent of the cementitious material mass, and not more than 35 percent. Admixtures shall consist of air-entraining admixture [and shall also include] [and may also include, as approved] [accelerator] [retarder] [water-reducing admixture. If water-reducer is used, it shall be used only at the dosage determined during mixture proportioning studies.] High range water-reducing admixtures and admixtures to produce flowable concrete shall not be used. Cementitious material content will range between [_____] and [_____] lb. per cu. yd. [Water-reducer dosage will normally be at the content recommended by the manufacturer unless studies show other dosage to be more appropriate.]

PART 3 EXECUTION

3.1 PREPARATION FOR PAVING

Before commencing paving, the following shall be performed. Surfaces to receive concrete shall be prepared as specified below. If used, forms shall be in place, cleaned, coated, and adequately supported. Any reinforcing steel needed shall be at the paving site. All transporting and transfer equipment shall be ready for use, clean, and free of hardened concrete and foreign material. Equipment for spreading, consolidating, screeding, finishing, and texturing concrete shall be at the paving site, clean and in proper working order. All equipment and material for curing and for protecting concrete from weather or mechanical damage shall be at the paving site, in proper working condition, and in sufficient amount for the entire placement. When hot, windy conditions during paving appear probable, equipment and material shall be at the paving site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete.

3.2 CONDITIONING OF UNDERLYING MATERIAL

****

NOTE: Edit bracketed items as appropriate.

****

3.2.1 General Procedures

Underlying material, [subgrade] [base course] or [subbase course], upon which concrete is to be placed shall be clean, damp, and free from debris, waste concrete or cement, frost, ice, and standing or running water. Prior to setting forms or placement of concrete, the underlying material shall be well drained and shall have been satisfactorily graded and uniformly compacted in accordance with the applicable Section of these specifications. The surface of the subgrade or base course shall be tested as to crown, elevation, and density in advance of setting forms or of concrete placement using slip-form techniques. High areas shall be trimmed to proper elevation. Low areas shall be filled and compacted to a condition similar to that of surrounding grade, or filled with concrete monolithically with the pavement. Where low areas are filled with concrete, the areas shall be marked, as approved, and cores for thickness determinations as required by paragraph, Flexural Strength and Thickness shall not be drilled in those areas. Any underlying material disturbed by construction operations shall be reworked and recompacted to specified density immediately in front of the paver. If a slipform paver is permitted and is used, the same underlying material under the paving lane shall be continued beyond the edge of the lane a sufficient distance and shall be thoroughly compacted and true to grade to provide a suitable trackline for the slipform paver and firm support for the edge of the paving lane. Where an open-graded granular base is required under the concrete, the Contractor shall select paving equipment and procedures which will operate properly on the base course without causing displacement or other damage.

3.2.2 Traffic on Underlying Material

****

NOTE: Use or delete this subparagraph as required to correlate with requirements specified in paragraph: Transporting and Transfer-Spreader Operations.

****

After the underlying material has been prepared for concrete placement, no equipment shall be permitted thereon. Subject to specific approval, crossing of the prepared subgrade or base course at specified intervals for construction purposes may be permitted, provided rutting or indentations do not occur; however, if traffic has been allowed to use the prepared subgrade or base course, the surface shall be reworked and reprepared to the satisfaction of the Contracting Officer before concrete is placed.

3.3 WEATHER LIMITATIONS

****
NOTE: Edit these paragraphs as appropriate.
****

3.3.1 Placement and Protection During Inclement Weather

The Contractor shall not commence placing operations when heavy rain or other damaging weather conditions appear imminent. At all times when placing concrete, the Contractor shall maintain on-site sufficient waterproof cover and means to rapidly place it over all unhardened concrete or concrete that might be damaged by rain. Placement of concrete shall be suspended whenever rain or other damaging weather commences to damage the surface or texture of the placed unhardened concrete, washes cement out of the concrete, or changes the water content of the surface concrete. All unhardened concrete shall be immediately covered and protected from the rain or other damaging weather. Any pavement damaged by rain or other weather shall be completely removed and replaced at the Contractor's expense as specified in paragraph, Repair, Removal, Replacement of Slabs.

3.3.2 Paving in Hot Weather

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NOTE: Additional information concerning hot weather concreting may be obtained from ACI 305R. Do not delete this paragraph or the next paragraphs dealing with weather.
****

When the ambient temperature during paving is expected to exceed 90 degrees F, the concrete shall be properly placed and finished in accordance with procedures previously submitted and as specified herein. The concrete temperature at time of delivery to the forms shall not exceed the temperature shown in the table below when measured in accordance with ASTM C 1064. Cooling of the mixing water or aggregates or placing in the cooler part of the day may be required to obtain an adequate placing temperature. An approved retarder may be used to facilitate placing and finishing. Steel forms and reinforcing shall be cooled as approved prior to concrete placement when steel temperatures are greater than 120 degrees F. Transporting and placing equipment shall be cooled or protected if necessary to maintain proper concrete-placing temperature. Concrete shall be placed continuously and rapidly at a rate of not less than 100 feet of paving lane per hour. The finished surfaces of the newly laid pavement shall be kept damp by applying a fog spray (mist) with approved spraying equipment until the pavement is covered by the curing medium. If necessary, wind screens shall be provided to protect the concrete from an evaporation rate in excess of 0.2 lb./square foot per hour, as determined by method shown in Figure 2.1.5 of ACI 305R.

Maximum Allowable Concrete Placing Temperature

Relative Humidity, Percent, During Time of Concrete Placement	Maximum Allowable Concrete Temperature in Degrees F
Greater than 60	90
40-60	85

Maximum Allowable Concrete Placing Temperature

Relative Humidity, Percent, During Time of Concrete Placement	Maximum Allowable Concrete Temperature in Degrees F
Less than 40	80

3.3.3 Prevention of Plastic Shrinkage Cracking

During hot weather with low humidity, and particularly with appreciable wind, the Contractor shall develop and institute measures to prevent plastic shrinkage cracks from developing. Particular care shall be taken if plastic shrinkage cracking is potentially imminent and especially if it has developed during a previous placement. Periods of high potential for plastic shrinkage cracking can be anticipated by use of Fig. 2.1.5 of ACI 305R. In addition to the protective measures specified in the previous paragraph, the concrete placement shall be further protected by erecting shades and windbreaks and by applying fog sprays of water, sprinkling, ponding, or wet covering. When such water treatment is stopped, curing procedures shall be immediately commenced. Plastic shrinkage cracks that occur shall be filled by injection of epoxy resin as directed, after the concrete hardens. Plastic shrinkage cracks shall never be troweled over or filled with slurry.

3.3.4 Paving in Cold Weather

****
NOTE: Retain bracketed item allowing accelerator if desired. Otherwise delete.
****

Special protection measures, as submitted and approved, and as specified herein, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. The ambient temperature of the air at the placing site and the temperature of surfaces to receive concrete shall be not less 40 degrees F. However, placement may begin when both the ambient temperature and the temperature of the underlying material are at least 35 degrees F and rising. When the ambient temperature is less than 50 degrees F, the temperature of the concrete when placed shall be not less than 50 degrees F nor more than 75 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. [Upon written approval, chemical admixture conforming to ASTM C 494Type C or E may be used provided it contains no calcium chloride.] Calcium chloride shall not be used at any time. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period. Pavement damaged by freezing shall be completely removed and replaced at the Contractor's expense as specified in paragraph REPAIR, REMOVAL, REPLACEMENT OF SLABS.

3.4 CONCRETE PRODUCTION

****
NOTE: Designer must correlate these paragraphs with

paragraph EQUIPMENT. Delete item in brackets if truck mixers are not permitted.
****

Batching, mixing, and transporting equipment shall have a capacity sufficient to maintain a continuous, uniform forward movement of the paver of not less than 2.5 feet per minute. Concrete shall be deposited in front of the paver within 45 minutes from the time cement has been charged into the mixing drum, except that if the ambient temperature is above 90 degrees F, the time shall be reduced to 30 minutes. No water shall be added to the concrete after it is batched [except that, if truck mixers are permitted, water may be added at the paving site to adjust the slump as approved, provided the maximum allowable w/c is not exceeded. Such water shall be injected under pressure as described in subparagraph, Truck Mixers]. Every load of concrete delivered to the paving site shall be accompanied by a batch ticket from the operator of the batching plant. Tickets shall be on approved forms and shall show at least the mass, or volume, of all ingredients in each batch delivered, [the water meter and revolution meter reading on truck mixers] and the time of day. Tickets shall be delivered to the placing foreman who shall keep them on file and deliver them to the Government weekly.

3.4.1 Batching and Mixing Concrete

The batching and mixing equipment and the operation thereof shall conform to the requirements of paragraph EQUIPMENT and as specified herein. All equipment shall be kept clean and in operable condition at all times. Scale pivots and bearings shall be kept clean and free of rust. Any equipment which fails to perform as specified shall immediately be removed from use until properly repaired and adjusted, or replaced.

3.4.2 Transporting and Transfer - Spreading Operations

****
NOTE: Edit bracketed items as appropriate. Requiring a travelling surge hopper should be considered for major airfield paving projects; a transfer spreader shall be required for all airfield pavement where traveling surge hopper is not required. Transporting equipment should be allowed to operate on the prepared underlying material in the paving lane only if previous experience has shown it to cause no problems; normally, it should not be allowed for airfield pavement, unless the base course has been stabilized with asphalt or portland cement. Be aware that operating hauling equipment in the paving lane will cause the paver to stop frequently, always producing a discontinuity in the pavement surface.
****

[The transporting and transfer equipment and the operation thereof shall conform to the requirements of paragraph EQUIPMENT and as specified herein. All equipment shall be kept clean and in operable condition at all times. Non-agitating equipment shall be used only on smooth roads and for haul time less than 15 minutes at all times during the work day. No transporting equipment shall be allowed to operate on the prepared and compacted underlying material in front of the paver-finisher.] [Equipment shall be allowed to operate on the underlying material only if approved in writing and only if no damage is done to the underlying material and its degree of compaction. Any disturbance to the underlying material that does occur shall be corrected, as approved, before the paver-finisher or the deposited concrete reaches the location of the disturbance and the equipment shall be replaced or procedures changed to prevent any future damage.] [An approved transfer spreader shall be used to transfer the concrete from hauling equipment outside the paving lane and to spread it evenly and strike it off to approximate grade in front of the paver-finisher.] [A travelling surge hopper shall be used to accept the concrete from the transporting equipment, store it as necessary, and feed it evenly across the paving lane at a depth which permits the paver to operate efficiently and at a rate that permits the paver to have a continuous forward movement.] Concrete shall be deposited as close as possible to its final position in the paving lane. All equipment shall be operated to discharge and transfer concrete without segregation. In no case shall dumping of concrete in discrete piles be permitted. No transfer or spreading operation which requires the use of front-end loaders, dozers, or similar equipment to distribute the concrete will be permitted. All batching and mixing, transporting, transferring, paving, and finishing shall be properly coordinated and controlled such that the paver-finisher has a continuous forward movement at a reasonably uniform speed from beginning to end of each paving lane, except for inadvertent equipment breakdown. Failure to achieve this shall require the Contractor to halt operations, regroup, and modify operations to achieve this requirement.

3.5 PAVING

****
NOTE: Designer must correlate these paragraphs with paragraph EQUIPMENT. Edit bracketed item on slipform paving as customary for project area.
****

3.5.1 General Requirements

The paving and finishing equipment and the operation thereof shall conform to the requirements of paragraph EQUIPMENT and as specified herein. All equipment shall be kept clean and properly operable at all times. Pavement shall be constructed with paving and finishing equipment utilizing rigid fixed forms [or by use of slipform paving equipment]. Paving and finishing equipment and procedures shall be capable of constructing paving lanes of the required width at a rate of at least 100 feet of paving lane per hour on a routine basis. Paving equipment and its operation shall be controlled, and coordinated with all other operations, such that the paver-finisher has a continuous forward movement, at a reasonably uniform speed, from beginning to end of each paving lane, except for inadvertent equipment breakdown. Workmen with foreign material on their footwear or construction equipment that might deposit foreign material shall not be permitted to walk or operate in the plastic concrete.

3.5.2 Consolidation

Concrete shall be consolidated with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. Gang-mounted vibrator spuds shall be spaced so as to thoroughly consolidate the entire paving lane, but not more than 30 inch spacing, and with the outside vibrators not more than 12 inches from the edge of the lane. The vibrators shall be inserted into the concrete to a depth that will provide the best full-depth consolidation but not closer to the underlying material than 2 inches. The vibrators or any tamping units in front of the paver shall be automatically controlled so that they shall be stopped immediately as forward motion ceases. Excessive vibration shall not be permitted. If the vibrators cause visible tracking in the paving lane, the paving operation shall be stopped and equipment and operations modified to prevent it. Concrete in small, odd-shaped slabs or in isolated locations inaccessible to the gang-mounted vibration equipment shall be vibrated with an approved hand-operated immersion vibrator. Vibrators shall not be used to transport or spread the concrete. Hand-operated vibrators shall not be operated in the concrete at one location for more than 20 seconds. For each paving train, at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators shall be maintained at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) shall require the immediate stopping of the paving operation and approved adjustment of the equipment or procedures.

3.5.3 Operation

When the paver approaches a header at the end of a paving lane, a sufficient amount of concrete shall be maintained ahead of the paver to provide a roll of concrete which will spill over the header. The amount of extra concrete shall be sufficient to prevent any slurry that is formed and carried along ahead of the paver from being deposited adjacent to the header. The spud vibrators in front of the paver shall be brought as close to the header as possible before they are lifted. Additional consolidation shall be provided adjacent to the headers by hand-manipulated vibrators. When the paver is operated between or adjacent to previously constructed pavement (fill-in lanes), provisions shall be made to prevent damage to the previously constructed pavement. Transversely oscillating screeds and extrusion plates shall overlap the existing pavement the minimum possible, but in no case more than 8 inches. These screeds or extrusion plates shall be electronically controlled from the previously placed pavement so as to prevent them from applying pressure to the existing pavement and to prevent abrasion of the pavement surface. The overlapping area of existing pavement surface shall at all times be kept completely free of any loose or bonded foreign material as the paver-finisher operates across it. When the paver travels on existing pavement, approved provisions shall be made to prevent damage to the existing pavement. Pavers using transversely oscillating screeds shall not be used to form fill-in lanes that have widths less than a full width for which the paver was designed or adjusted.

3.5.4 Required Results

The paver-finisher, and its gang-mounted vibrators, together with its operating procedures shall be adjusted and operated and coordinated with the concrete mixture being used to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. The screed or the extrusion plate shall be properly adjusted to produce a pavement surface true to line and grade. Any necessary adjustment to compensate for surging behind the screed or for inadequate height of surface after paving shall be carefully made and checked frequently. The paver-finishing operation shall produce a surface finish free of irregularities, tears, voids of any kind, and any other discontinuities. It shall produce only a very minimum of paste at the surface; never more than 3/32 inch cover over the top layer of coarse aggregate. The paver-finisher shall make only one pass across the pavement; multiple passes will not be permitted. The equipment and its operation shall produce a finished surface requiring no hand finishing other than the use of cutting straightedges, except in very infrequent instances. If any equipment or operation fails to produce the above results, the paving shall be stopped, the equipment shall be replaced or properly adjusted, the operation shall be appropriately modified, or the mixture proportions modified, in order to produce the required results before recommencing paving. No water, other than true fog sprays (mist) as specified in paragraph, Prevention of Plastic Shrinkage Cracking, shall be applied to the concrete or the concrete surface during paving and finishing.

3.5.5 Fixed Form Paving

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NOTE: Fixed-form paving should always be included as an option or mandatory item as appropriate.
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Paving equipment for fixed-form paving and the operation thereof shall conform to the requirements of paragraph EQUIPMENT, all requirements specified above under paragraph PAVING and as specified herein.

3.5.5.1 Forms for Fixed-Form Paving

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NOTE: Delete subparagraph e. when overlay pavements are not required.
****

a. Forms shall be steel, except that wood forms may be used for curves having a radius of 150 feet or less, and for fillets. Forms shall be equal in depth to the edge thickness of the slab as shown on the drawings. Forms shall be in one piece for the full depth required, except as permitted below. Under no conditions shall forms be adjusted by filling or excavating under the forms to an elevation other than the bottom of the pavement slab. Where the project requires several different slab thicknesses, forms may be built up with metal or wood to provide an increase in depth of not more than 25 percent. The required form depth may be obtained by securely bolting or welding to the bottom of the form a tubular metal section of the proper thickness or by securely bolting wood planks to the bottom of the form. The tubular metal section or wood planks shall completely cover the underside of the base of the form and shall extend beyond the edge of the base a sufficient distance to provide the necessary stability. The base width of the one-piece form, or built-up form, shall be not less than eight-tenths of the vertical height of the form, except that forms 8 inches or less in vertical height shall have a base width not less than the vertical height of the form. Forms shall not be built-up by adding to the top. The top surface of each form section shall not vary more than 1/16 inch in 12 feet from a true line. The face of the form shall not vary more than 3/16 inch in 12 feet from a true plane. Forms with battered top surfaces or distorted faces or bases shall be removed from the project. Where keyway forms are required, they shall be rigidly attached to the main form so no displacement can take place. Metal keyway forms shall be tack-welded to steel forms. Keyway forms shall be so aligned that there is no variation over 1/4 inch either vertically or horizontally, when tested with a 12 foot template after forms are set, including tests across form joints.

b. Steel forms shall be furnished in sections not less than 10 feet in length, except that on curves having a radius of 150 feet or less, the length of the sections shall be 5 feet unless the sections are flexible or curved to the proper radius. Each 10 foot length of form shall be provided with at least three form braces and pin sockets so spaced that the form will be rigidly braced throughout its length. Lock joints between form sections shall be free from play or movement. Forms shall be free of warps, bends, or kinks.

c. Wood forms for curves and fillets shall be made of well-seasoned, surfaced plank or plywood, straight, and free from warp or bend. Wood forms shall be adequate in strength and rigidly braced.

d. The forms shall be set on firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire length and base width. Underlying material shall be thoroughly compacted and trimmed to grade before forms are set in place. Setting forms on blocks or on built-up spots of underlying material will be not permitted under any condition. The form sections shall be staked into position and tightly locked together. The length of pins and quantity provided in each section shall be sufficient to hold the form at the correct line and grade. When tested with a straightedge, the top of the installed form shall conform to the requirements specified for the finished surface of the concrete, and the longitudinal axis of the upstanding leg shall not vary more than 1/4 inch from the straightedge. Conformity to the alignment and grade elevations shown on the drawings shall be checked and necessary corrections shall be made immediately prior to placing the concrete. Forms shall be set well in advance of concrete placement. The forms shall be cleaned and oiled each time before concrete is placed. No concrete shall be placed until setting of forms has been checked and approved by the CQC team.

e. Forms for overlay pavements and for other locations where forms must be set on existing pavements shall be held securely in place with stakes or by other approved methods. Holes in existing pavements for form stakes shall be carefully drilled by methods which will not crack or spall the existing pavement. After use, the holes shall be filled as directed. Any method which does not hold the form securely or which damages the existing pavement shall be immediately discontinued. Prior to setting forms for paving operations, the Contractor shall demonstrate his proposed form setting procedures at an approved location and shall not proceed further until the proposed method is approved.

3.5.5.2 Form Removal

Forms shall remain in place at least 12 hours after the concrete has been placed. When conditions are such that the early strength gain of the concrete is delayed, the forms shall be left in place for a longer time, as directed. Forms shall be removed by procedures that do not injure the concrete. Bars or heavy metal tools shall not be used directly against the concrete in removing the forms. Any concrete found to be defective after form removal shall be repaired promptly, using procedures specified hereinafter or as directed.

3.5.6 Slipform Paving

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NOTE: Retain slipform paving as an option unless there are specific, valid reasons for deleting it. Be sure all other paragraphs correlate with choice made here.

****

3.5.6.1 General

Paving equipment for slipform paving and the operation thereof shall conform to the requirement of paragraph EQUIPMENT, all requirements specified above in subparagraphs, General, Consolidation, Operation, and Required Results, and as specified herein. The slipform paver shall shape the concrete to the specified and indicated cross section, meeting all tolerances, in one pass. The slipform paver shall finish the surface and edges so that only a very minimum isolated amount of hand finishing is required. If the paving operation does not meet the above requirements and the specified tolerances, the operation shall be immediately stopped, and the Contractor shall regroup and replace or modify any equipment as necessary, modify paving procedures or modify the concrete mix, in order to resolve the problem. The slipform paver shall be automatically electronically controlled from a taut wire guideline for horizontal alignment and on both sides from a taut wire guideline for vertical alignment, except that electronic control from a ski operating on a previously constructed adjoining lane shall be used where applicable for either or both sides. Automatic, electronic controls for vertical alignment shall always be used on both sides of the lane. Control from a slope-adjustment control or control operating from the underlying material shall never be used. If approved by the Contracting Officer after a preconstruction demonstration, automatic laser controls may be used in lieu of or to supplement the taut wire guidelines. Side forms on slipform pavers shall be properly adjusted so that the finished edge of the paving lane meets all specified tolerances. Dowels in longitudinal construction joints shall be installed as specified below. The installation of these dowels by dowel inserters attached to the paver or by any other means of inserting the dowels into the plastic concrete shall not be permitted. [If a keyway is required, a 26 gauge thick metal keyway liner shall be installed as the keyway is extruded. [The keyway liner shall be protected and shall remain in place and become part of the joint.]]

3.5.6.2 Guideline for Slipform Paving

Guidelines shall be accurately and securely installed well in advance of concrete placement. Supports shall be provided at necessary intervals to eliminate all sag in the guideline when properly tightened. The guideline shall be high strength wire set with sufficient tension to remove all sag between supports. Supports shall be securely staked to the underlying material or other provisions made to ensure that the supports will not be displaced when the guideline is tightened or when the guideline or supports are accidentally touched by workmen or equipment during construction. The appliances for attaching the guideline to the supports shall be capable of easy adjustment in both the horizontal and vertical directions. When it is necessary to leave gaps in the guideline to permit equipment to use or cross underlying material, provisions shall be made for quickly and accurately replacing the guideline without any delay to the forward progress of the paver. Supports on either side of the gap shall be secured in such a manner as to avoid disturbing the remainder of the guideline when the portion across the gap is positioned and tightened. The guideline across the gap and adjacent to the gap for a distance of 200 feet shall be checked for horizontal and vertical alignment after the guideline across the gap is tightened. Vertical and horizontal positioning of the guideline shall be such that the finished pavement shall conform to the alignment and grade elevations shown on the drawings within the specified tolerances for grade and smoothness. The specified tolerances are intended to cover only the normal deviations in the finished pavement that may occur under good supervision and do not apply to setting of the guideline. The guideline shall be set true to line and grade.

3.5.6.3 Laser Controls

If the Contractor proposes to use any type of automatic laser controls, a detailed description of the system shall be submitted and a trial field demonstration shall be performed in the presence of the Contracting Officer at least one week prior to start of paving. Approval of the control system will be based on the results of the demonstration and on continuing satisfactory operation during paving.

3.5.7 Placing Reinforcing Steel

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NOTE: Delete bracketed item if CRCP is not being constructed.

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The type and amount of steel reinforcement shall be as shown on the drawings. For pavement thickness of 12 inches or more, the reinforcement steel shall be installed by the strike-off method wherein a layer of concrete is deposited on the underlying material, consolidated, and struck to the indicated elevation of the steel reinforcement. The reinforcement shall be laid upon the prestruck surface, and the remaining concrete shall then be placed and finished in the required manner. When placement of the second lift causes the steel to be displaced horizontally from its original position, provisions shall be made for increasing the thickness of the first lift and depressing the reinforcement into the unhardened concrete to the required elevation. The increase in thickness shall be only as necessary to permit correct horizontal alignment to be maintained. Any portions of the bottom layer of concrete that have been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with newly mixed concrete without additional cost to the Government. For pavements less than 12 inches thick, the reinforcement shall be positioned on suitable chairs securely fastened to the subgrade prior to concrete placement. Concrete shall be vibrated after the steel has been placed. Regardless of placement procedure, the reinforcing steel shall be free from coatings which could impair bond between the steel and concrete, and laps in the reinforcement shall be as indicated. In lieu of the above, automatic reinforcement depressing attachments may be used to position the reinforcement, either bar mats or welded wire fabric, provided the entire operation is approved by the Contracting Officer. Regardless of the equipment or procedures used for installing reinforcement, the Contractor shall ensure that the entire depth of concrete is adequately consolidated. [If reinforcing for Continuously Reinforced Concrete Pavement (CRCP) is required, the entire operating procedure and equipment proposed shall be submitted for approval at least 30 days prior to proposed start of paving.]

3.5.8   Placing Dowels and Tie Bars

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NOTE: Delete references to slipform paving installation of dowels and tie bars if slipform paving is not allowed. Delete references to installation in contraction joints if not required. Delete bracketed references to tie bars, if tie bars are not used.

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The method used in installing and holding dowels in position shall ensure that the error in alignment of any dowel from its required alignment after the pavement has been completed will not be greater than 1/8 in. per ft. Except as otherwise specified below, location of dowels shall be within a horizontal tolerance of plus or minus 5/8 inch. The Contractor shall furnish an approved template for checking the alignment and position of the dowels. The portion of each dowel intended to move within the concrete or expansion cap shall be painted with one coat of the specified paint. When dry, the painted portion shall be wiped clean and coated with a thin, even film of lubricating oil before the concrete is placed. Pipe used as dowels shall be filled with a stiff sand-asphalt mixture or portland-cement mortar. Dowels [and tie bars] in joints shall be omitted when the center of the dowel [or tie bar] is located within a horizontal distance from an intersecting joint equal to or less than one-fourth of the slab thickness. Dowels shall be installed as specified in the following subparagraphs.

3.5.8.1   Contraction Joints

Dowels [and tie bars] in longitudinal and transverse contraction joints within the paving lane shall be held securely in place, as indicated, by means of rigid metal frames or basket assemblies of an approved type. The assemblies shall consist of a framework of metal bars or wires arranged to provide rigid support for the dowels [and the tie bars] throughout the paving operation, with a minimum of four continuous bars or wires extending along the joint line. The dowels [and tie bars] shall be welded to the assembly or held firmly by mechanical locking arrangements that will prevent them from rising, sliding out, or becoming distorted during paving operations. The basket assemblies shall be held securely in the proper location by means of suitable pins or anchors. At the Contractor's option, in lieu of the above, dowels [and tie bars] in contraction joints shall be installed near the front of the paver by insertion into the plastic concrete using approved equipment and procedures. Approval will be based on the results of a preconstruction demonstration which the Contractor shall conduct, showing that the dowels [and tie bars] are installed within specified tolerances.

3.5.8.2   Construction Joints-Fixed Form Paving

Installation of dowels [and tie bars] shall be by the bonded-in-place method. Installation by removing and replacing in preformed holes will not be permitted. Dowels [and tie bars] shall be prepared and placed across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms. [If split dowels are approved and used, the female portion of the split dowel shall be bonded in the initially placed pavement lane. The female portion of the split dowel shall be securely fastened to the pavement form and shall maintain the proper position and alignment of the dowel during concrete placement so that no mortar or other foreign material will enter the socket or coupling. Before the split dowels are assembled, the external and internal threads shall be cleaned thoroughly to remove all cement, cement mortar, grit, dirt, and other foreign matter. In the final assembly, a minimum torque of 200 ft-lbs shall be applied.] The spacing of dowels [and tie bars] in construction joints shall be as indicated, except that, where the planned spacing cannot be maintained because of form length or interference with form braces, closer spacing with additional dowels [or tie bars] shall be used.

3.5.8.3 Dowels Installed in Hardened Concrete

Dowels installed in hardened concrete, such as in longitudinal construction joints for slipform paving, in joints between new and existing pavement, and similar locations, shall be installed by bonding the dowels into holes drilled into the hardened concrete. The installation of dowels in longitudinal construction joints by dowel inserters attached to a slipform paver or by any other means of inserting the dowels into the plastic concrete shall not be permitted. However, when paving two lanes together with a longitudinal contraction joint between, any dowels required may be installed in this joint with an approved inserter. Holes approximately 1/8 inch greater in diameter than the dowels shall be drilled into the hardened concrete with rotary core drills to receive the dowels. In lieu of rotary drills, the contractor may use percussion drills, provided that spalling at the collar of the hole does not occur. Regardless of the type of drill used, the drill shall be held rigidly in exact alignment by means of a stable jig or framework, solidly supported; gang drills meeting this are acceptable. Any damage to the concrete face during drilling shall be repaired as directed; continuing damage shall require modification of the equipment and operation. Dowels shall be bonded in the drilled holes using epoxy resin. Epoxy resin shall be injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel shall not be permitted. The dowels shall be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic collar fitted around the dowel. The vertical alignment of the dowels shall be checked by placing a straightedge on the surface of the pavement over the top of the dowel and measuring the vertical distance between the straightedge and the beginning and ending point of the exposed part of the dowel. The horizontal alignment shall be checked with a framing square. Dowels required to be installed in any joints between new and existing concrete shall be grouted in holes drilled in the existing concrete, all as specified above. [Where tie bars are required in longitudinal construction joints of slipform pavement, bent tie bars shall be installed at the paver, in front of the transverse screed or extrusion plate. If tie bars are required, a standard keyway shall be constructed, and the bent tie bars shall be inserted into the plastic concrete through a 26 gauge thick metal keyway liner. Tie bars shall not be installed in preformed holes. The keyway liner shall be protected and shall remain in place and become part of the joint. When bending tie bars, the radius of bend shall not be less than the minimum recommended for the particular grade of steel in the appropriate material standard. Before placement of the adjoining paving lane, the tie bars shall be straightened, using procedures which will not spall the concrete around the bar.]

3.5.8.4 Expansion Joints

****
NOTE: Delete if not required.
****

Dowels in expansion joints shall be installed as shown using appropriate procedures specified above.

3.6 FINISHING

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NOTE: Edit bracketed items as appropriate. Retain slipform paving subparagraph except when it is prohibited elsewhere. Delete Other Types of Finishing Equipment here and in PART 1, if not wanted. Hand finishing is to be allowed only for isolated, small, odd-shaped slabs or places inaccessible to the paver.
****

The finishing machine, or paver-finisher, shall meet all requirements specified in paragraph EQUIPMENT and herein. Finishing operations shall be a continuing part of placing operations starting immediately behind the strike-off of the paver and the machines shall be designed and operated to strike off, screed, and consolidate the concrete. Initial finishing shall be provided by the transverse screed or extrusion plate. The sequence of operations shall be transverse finishing, longitudinal machine floating if used, straightedge finishing, texturing, and then edging of joints. Finishing shall be by the machine method. The hand method shall be used only infrequently and only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. [When approved, the hand finishing method may also be used for separate, isolated slabs during removal and replacement type repair operations.] Supplemental hand finishing for machine finished pavement shall be kept to an absolute minimum. Equipment to be used for supplemental hand finishing shall primarily be 10 to 12 feet cutting straightedges; only very sparing use of bull floats shall be allowed. Any machine finishing operation which requires appreciable hand finishing, other than a moderate amount of straightedge finishing, shall be immediately stopped and proper adjustments made or the equipment replaced. Every effort shall be made to prevent bringing excess paste to the surface and any operations which produce more than 3/32 inch of paste (mortar, water, laitance, etc.) over the top layer of coarse aggregate shall be halted immediately and the equipment, mixture, or procedures modified as necessary. Compensation shall be made for surging behind the screeds or extrusion plate and settlement during hardening and care shall be taken to ensure that paving and finishing machines are properly adjusted so that the finished surface of the concrete (not just the cutting edges of the screeds) will be at the required line and grade. Surface checks shall be made regularly and paving operations immediately halted and adjustments made whenever compensation is inadequate. Screed and float adjustments of the machines shall be checked at the start of each day's paving operations and more often if required. Machines that cause frequent delays due to mechanical failure shall be replaced. When machines ride the edge of a previously constructed slab, the edge shall be kept clean and provision shall be made to protect the surface of the slab. Clary screeds, "bridge deck" finishers, or other rotating pipe or tube type equipment will not be permitted. Finishing equipment and tools shall be maintained clean and in an approved condition. At no time shall water be added to the surface of the slab with the finishing equipment or tools, or in any other way, except for fog (mist) sprays specified to prevent plastic shrinkage cracking.

3.6.1 Longitudinal Floating

When the equipment contains a mechanical, longitudinal, oscillating float, the float shall be operated to smooth and finish the pavement immediately behind the transverse screed or extrusion plate. The float shall be operated maintaining contact with the surface at all times. Care shall be taken to prevent working paste to the surface in excess of the amount specified above.

3.6.2 Other Types of Finishing Equipment

Concrete finishing equipment of types other than those specified above may be used on a trial basis, when specifically approved, except that rotating pipe or tubes or bridge deck finishers will not be permitted. Approval will be given after demonstration on a test section prior to start of construction, and provided the Contracting Officer determines that the pavement produced is better than that produced by the specified equipment. The use of equipment that fails to produce finished concrete of the required quality, using concrete proportions and slump as specified, shall be discontinued, and the concrete shall be finished with specified equipment and in the manner specified above. Vibrating screeds or pans shall be used only for isolated slabs where hand finishing is permitted as specified, and only where specifically approved. Slipform paving equipment shall not be operated on fixed forms unless approved in writing prior to use.

3.6.3 Machine Finishing With Fixed Forms

The machine shall be designed to ride the forms and shall be operated to screed and consolidate the concrete. Machines that cause displacement of the forms shall be replaced. The machine shall make only one pass over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, the operation shall be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.

3.6.4 Machine Finishing With Slipform Pavers

The slipform paver shall be operated so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Any equipment or procedure that fails to meet these specified requirements shall immediately be replaced or modified as necessary. A self-propelled nonrotating pipe float may be used if the Contractor desires while the concrete is still plastic, to remove minor irregularities and score marks. The pipe float shall be 6 to 10 inches in diameter and sufficiently long to span the full paving width when oriented at an angle of approximately 60 degrees with the center line. Only one pass of the pipe float shall be allowed. If there is sufficient concrete slurry or fluid paste on the surface that it runs over the edge of the pavement, the paving operation shall be immediately stopped and the equipment, mixture, or operation modified to prevent formation of such slurry. Any slurry which does run down the vertical edges shall be immediately removed by hand, using stiff brushes or scrapers. No slurry, concrete or concrete mortar shall be used to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens. Slabs having areas of edge slump in excess of the specified tolerances shall be removed and replaced in accordance with paragraph, REPAIR, REMOVAL, REPLACEMENT OF SLABS; repair operations on such areas will not be permitted.

3.6.5 Surface Correction and Testing

After all other finishing is completed but while the concrete is still plastic, minor irregularities and score marks in the pavement surface shall be eliminated by means of cutting straightedges. Such straightedges shall be 12 feet in length and shall be operated from the sides of the pavement and from bridges. A straightedge operated from the side of the pavement shall be equipped with a handle 3 feet longer than one-half the width of the pavement. The surface shall then be tested for trueness with a straightedge held in successive positions parallel and at right angles to the center line of the pavement, and the whole area covered as necessary to detect variations. The straightedge shall be advanced along the pavement in successive stages of not more than one-half the length of the straightedge. Depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. Projections above the required elevation shall also be struck off and refinished. The straightedge testing and finishing shall continue until the entire surface of the concrete is free from observable departure from the straightedge and conforms to the surface requirements specified in paragraph ACCEPTABILITY OF WORK AND PAYMENT ADJUSTMENTS. Long-handled, flat bull floats shall be used very sparingly and only as necessary to correct minor, scattered surface defects. If frequent use of bull floats is necessary, the paving operation shall be stopped and the equipment, mixture or procedures adjusted to eliminate the surface defects. Finishing with hand floats and trowels shall be held to the absolute minimum necessary. Extreme care shall be taken to prevent overfinishing joints and edges. The surface finish of the pavement shall be produced essentially by the finishing machine and not by subsequent hand finishing operations. All hand finishing operations shall be subject to approval and shall be modified when directed. No water shall be added to the pavement surface during these operations.

3.6.6 Hand Finishing

Hand finishing operations shall be used only as specified above.

3.6.6.1 Equipment

In addition to approved mechanical internal vibrators for consolidating the concrete, a strike-off and tamping template and a longitudinal float shall be provided for hand finishing. The template shall be at least 1 foot longer than the width of pavement being finished, of an approved design, and sufficiently rigid to retain its shape, and shall be constructed of metal or other suitable material shod with metal. The longitudinal float shall be at least 10 feet long, of approved design, and rigid and substantially braced, and shall maintain a plane surface on the bottom . Grate tampers (jitterbugs) shall not be used.

3.6.6.2 Finishing and Floating

As soon as placed and vibrated, the concrete shall be struck off and screeded to the crown and cross section and to such elevation above grade that when consolidated and finished, the surface of the pavement will be at the required elevation. In addition to previously specified complete coverage with handheld immersion vibrators, the entire surface shall be tamped with the strike-off and tamping template, and the tamping operation continued until the required compaction and reduction of internal and surface voids are accomplished (grate tampers shall not be used). Immediately following the final tamping of the surface, the pavement shall be floated longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, additional concrete shall be placed and screeded, and the float operated until a satisfactory surface has been produced. The floating operation shall be advanced not more than half the length of the float and then continued over the new and previously floated surfaces. Long-handled, flat bull floats shall be used very sparingly and only as necessary to correct minor, scattered surface defects. If frequent use of bull floats is necessary, the operation shall be stopped and adjusted to eliminate the surface defects. Finishing with hand floats and trowels shall be held to the absolute minimum necessary. Extreme care shall be taken to prevent overfinishing joints and edges. No water shall be added to the pavement during finishing operations.

3.6.7 Texturing

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NOTE: Designer must select type of texturing desired, retain that subparagraph, and delete the others. A genuine effort should be made to determine the type of texturing, if any, desired by the using service. If no guidance is given, the usual default method should be burlap drag. Edit bracketed phrases as appropriate. Do not use artificial turf drag for Air Force projects.

****

Before the surface sheen has disappeared and before the concrete hardens, the surface of the pavement shall be given a texture as described herein. After curing is complete, all textured surfaces shall be thoroughly power broomed to remove all debris. [Any type of transverse texturing shall produce grooves in straight lines across each lane within a tolerance of plus or minus 1/2 inch of a true line.]

3.6.7.1 Fabric Drag Surface Finish

Surface texture shall be applied by dragging the surface of the pavement, in the direction of the concrete placement, with an approved fabric drag. The drag shall be operated with the fabric moist, and the fabric shall be cleaned or changed as required to keep clean. The dragging shall be done so as to produce a uniform finished surface having a fine sandy texture without disfiguring marks.

3.6.7.2 Broom Texturing

Surface texture shall be applied using an approved mechanical stiff bristle broom drag of a type that will uniformly score the surface. The broom shall be operated to score the surface transverse to the pavement center line. The broom shall be capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure. Successive passes of the broom shall be overlapped the minimum necessary to obtain a uniformly textured surface. Brooms shall be washed thoroughly at frequent intervals during use. Worn or damaged brooms shall be removed from the job site. Brooming should be completed before the concrete has hardened to the point where the surface will be unduly torn or roughened, but after hardening has progressed enough so that the mortar will not flow and reduce the sharpness of the scores. Specific requirements for the texturing will be given on the drawings, but, if not given, the scores shall be uniform in appearance and approximately 1/16 inchin depth but not more than 1/8 inch in depth. Hand brooming will be permitted only on isolated odd shaped slabs or slabs where hand finishing is permitted. For hand brooming, the brooms shall have handles longer than half the width of slab to be finished. The hand brooms shall be drawn transversely across the surface from the center line to each edge with slight overlapping strokes.

3.6.7.3 Wire-Comb Texturing

Surface texture shall be applied using an approved mechanical wire comb drag. The wire comb drag shall be operated to comb the surface transverse to the pavement center line. The comb shall be capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure. Successive passes of the comb shall be overlapped the minimum necessary to obtain a continuous and uniformly textured surface. Texturing shall be completed before the concrete has hardened to the point where the surface and edges will be unduly torn, but after hardening has progressed to the point where the serrations will not close up. Specific requirements for the texturing shall be as indicated on the drawings, but if not shown, the serrations shall be 1/16 to 3/16 inchdeep 1/16 to 1/8 inch wide, and spaced 3/8 inch apart.

3.6.7.4 Surface Grooving

The areas indicated on the drawings shall be grooved with a spring tine drag producing individual grooves 1/4 inch deep and 1/4 inch wide at a spacing between groove centerlines of 2 inches. These grooves shall be cut perpendicular to the centerline. Before grooving begins, the concrete shall be allowed to attain sufficient strength to prevent aggregate spalling. Grooves shall not be cut within 6 inches of a transverse joint or crack and they shall not be cut through neoprene compression seals.

3.6.8 Edging

After texturing has been completed, the edge of the slabs along the forms, along the edges of slipformed lanes, and at the joints shall be carefully finished with an edging tool to form a smooth rounded surface of 1/8 inch radius. Tool marks shall be eliminated, and the edges shall be smooth and true to line. No water shall be added to the surface during edging. Extreme care shall be taken to prevent overworking the concrete.

3.6.9 Outlets in Pavement

Recesses for the tie-down anchors, lighting fixtures, and other outlets in the pavement shall be constructed to conform to the details and dimensions shown. The concrete in these areas shall be carefully finished to provide a surface of the same texture as the surrounding area that will be within the requirements for plan grade and surface smoothness.

3.7 CURING

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NOTE: Retain bracketed item at end of first paragraph mandating 24 hour moist cure only where locally required and only where approved by the

using service.
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3.7.1 Protection of Concrete

Concrete shall be continuously protected against loss of moisture and rapid temperature changes for at least 7 days from the completion of finishing operations. Unhardened concrete shall be protected from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Sufficient sheet material to protect unhardened concrete from rain shall be at the paver at all times. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period. If any selected method of curing does not afford the proper curing and protection against concrete cracking, the damaged pavement shall be removed and replaced, and another method of curing shall be employed as directed. Curing shall be accomplished by one of the following methods [except that only moist curing shall be used for the first 24 hours].

3.7.2 Membrane Curing

A uniform coating of white-pigmented, membrane-forming, curing compound shall be applied to the entire exposed surface of the concrete as soon as the free water has disappeared from the surface after [finishing] [moist curing ceases]. If evaporation is high and no moisture is present on the surface even though bleeding has not stopped, fog sprays shall be used to keep the surface moist until setting of the cement occurs and bleeding is complete. Curing compound shall then be immediately applied. Along the formed edge faces, it shall be applied immediately after the forms are removed. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water, and the curing compound applied as soon as the free water disappears. The curing compound shall be applied to the finished surfaces by means of an approved automatic spraying machine. The spraying machine shall be self-propelled and shall span the newly paved lane. The machine shall have one or more spraying nozzles that can be controlled and operated to completely and uniformly cover the pavement surface with the required amount of curing compound. The curing compound in the drum used for the spraying operation shall be thoroughly and continuously agitated mechanically throughout the full depth of the drum during the application. Air agitation may be used only to supplement mechanical agitation. Spraying pressure shall be sufficient to produce a fine spray as necessary to cover the surface thoroughly and completely with a uniform film. Spray equipment shall be kept clean and properly maintained and the spray nozzle or nozzles shall have adequate wind shields. The curing compound shall be applied with an overlapping coverage that will give a two-coat application at a coverage of 400 square feet per gallon, plus or minus 5.0 percent for each coat. A one-coat application may be applied provided a uniform application and coverage of 200 square feet per gallon, plus or minus 5.0 percent is obtained. The application of curing compound by hand-operated, mechanical powered pressure sprayers will be permitted only on odd widths or shapes of slabs where indicated and on concrete surfaces exposed by the removal of forms. When the application is made by hand-operated sprayers, the second coat shall be applied in a direction approximately at right angles to the direction of the first coat. The compound shall form a uniform, continuous, cohesive film that will not check, crack, or peel and that will be free from pinholes and other discontinuities. If pinholes, abrasions, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be immediately resprayed. The surfaces adjacent to joint sawcuts shall be cleaned and resprayed with curing compound immediately after cutting. Approved standby facilities for curing concrete pavement shall be provided at an accessible location at the job site for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.7.3 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period, or until curing compound is applied, commencing immediately after finishing. If forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Surfaces shall be cured by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Burlap and mats shall be clean and free from any contamination and shall be completely saturated before being placed on the concrete. The Contractor shall have an approved work system to ensure that moist curing is continuous 24 hours per day and that the entire surface is wet.

3.7.4 Impervious Sheet Curing

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NOTE: Retain this paragraph only where local experience has proven that impervious sheeting provides satisfactory curing.

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All surfaces shall be thoroughly wetted and then completely covered with the sheeting. Sheeting shall be at least 18 inches wider than the concrete surface to be covered. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 12 inches and securely weighted to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears of holes appear during the curing period.

3.8 JOINTS

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NOTE: Edit bracketed items in following subparagraphs to conform to design requirements. Even if not required, dowels should be permitted for construction joints. The effect of tie bars on the pavement action should be analyzed before requiring or permitting their use. Remove joint types not

required in the project.
****

3.8.1 General Requirements for Joints

Joints shall conform to the details indicated and shall be perpendicular to the finished grade of the pavement. All joints shall be straight and continuous from edge to edge or end to end of the pavement with no abrupt offset and no gradual deviation greater than 1/2 inch.Before commencing construction, the Contractor shall submit for approval a control plan and equipment to be used for ensuring that all joints are straight from edge to edge of the pavement within the above tolerances. Where any joint fails to meet these tolerances, the slabs adjacent to the joint shall be removed and replaced at no additional cost to the Government. No change from the jointing pattern shown on the drawings shall be made without written approval of the Contracting Officer. Sealing of joints shall be in accordance with Section [_____].

3.8.2 Longitudinal Construction Joints

Longitudinal construction joints between paving lanes shall be located as indicated. Dowels [or keys] [or tie bars] shall be installed in the longitudinal construction joints, or the edges shall be thickened as indicated. [Dowels] [Tie bars] shall be installed in conformance with paragraph, Placing Dowels and Tie Bars. [When the concrete is placed using stationary forms, metal keyway forms securely fastened to the concrete form shall be used to form a keyway in the plastic concrete. When the concrete is placed using slipform pavers, a keyway shall be formed in the plastic concrete by means of metal forms permanently attached to the side forms or by means of preformed metal keyway liners, which are inserted during the slipform operations and may be left in place. The dimensions of the keyway forms shall not vary more than plus or minus 1/8 inch from the dimensions indicated and shall not deviate more than plus or minus 1/4 inch from the mid-depth of the pavement. There shall be no abrupt offset either horizontally or vertically in the completed keyway. If any length of completed keyway of 5 feet or more fails to meet the above tolerances, dowels shall be installed in that part of the joint by drilling holes in the hardened concrete and grouting the dowels in place with epoxy resins using approved materials and procedures.] After the end of the curing period, longitudinal construction joints shall be sawed to provide a groove at the top for sealant conforming to the details and dimensions indicated.

3.8.3 Transverse Construction Joints

Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for 30 minutes or longer. When concrete placement cannot be continued, the transverse construction joint shall be installed at a planned transverse joint, if possible. Transverse construction joints shall be constructed by utilizing headers and the very minimum amount of hand placement and finishing techniques. Pavement shall be constructed with the paver as close to the header as possible, and the paver shall be run out completely past the header. Transverse construction joints installed at a planned transverse joint shall be constructed as shown or, if not shown otherwise, shall be dowelled. Those not at a planned transverse joint shall be constructed with tie bars and shall not be sawed or sealed.

3.8.4 Expansion Joints

Expansion joints shall be formed where indicated, and about any structures and features that project through or into the pavement, using joint filler of the type, thickness, and width indicated, and shall be installed to form a complete, uniform separation between the structure and the pavement. The filler shall be attached to the original concrete placement with adhesive or other fasteners and shall extend the full slab depth. Adjacent sections of filler shall be fitted tightly together, and the filler shall extend across the full width of the paving lane or other complete distance in order to prevent entrance of concrete into the expansion space. Edges of the concrete at the joint face shall be finished with an edger with a radius of 1/8 inch. The joint filler strips shall be installed 3/4 inch below the pavement surface with a slightly tapered, dressed-and-oiled wood strip or other approved material temporarily secured to the top of the filler to form a recess to be filled with joint sealant. The wood strip shall be removed soon after the concrete has set and the reservoir temporarily filled with an approved material to protect the reservoir until the joint sealer is installed. Expansion joints shall be constructed with [dowels] [thickened edges] for load transfer.

3.8.5 Slip Joints

Slip joints shall be installed where indicated using the specified materials. Preformed joint filler material shall be attached to the face of the original concrete placement with adhesive or other fasteners. Bituminous material shall be applied to cover the entire surface of the face of the original concrete placement to a depth of 1/4 inch plus or minus 1/16 inch. Only a material which will remain in place on the vertical surface shall be used. In each case a 3/4 inch deep reservoir for joint sealant shall be constructed at the top of the joint. Edges of the joint face shall be finished with an edger with a radius of 1/8 inch.

3.8.6 Contraction Joints

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NOTE: Edit bracketed items as appropriate. Normally, it is better to delete insert type joints and allow only sawed joints for both longitudinal and transverse contraction joints, especially for slipformed pavement. Do not use insert type joints for Air Force pavements.

****

Transverse and longitudinal contraction joints shall be of the weakened-plane or dummy type and shall be constructed as indicated. Longitudinal contraction joints shall be constructed by sawing a groove in the hardened concrete with a power-driven saw in conformance with requirements for sawed joints, unless otherwise approved in writing. Transverse contraction joints shall be constructed in conformance with requirements for [sawed joints] [insert-type contraction joints.]

3.8.6.1 Sawed Joints

Sawed contraction joints shall be constructed by sawing an initial groove in the concrete with a 1/8 inch blade to the indicated depth. During sawing of joints, and again 24 hours later, the CQC team shall inspect all exposed lane edges for development of cracks below the saw cut, and shall immediately report results to the Contracting Officer. If the Contracting Officer determines that there are more uncracked joints than desired, the

Contractor will be directed to saw succeeding joints 25 percent deeper than originally indicated at no additional cost to the Government. After expiration of the curing period, the upper portion of the groove shall be widened by sawing to the width and depth indicated for the joint sealer. The time of initial sawing shall vary depending on existing and anticipated weather conditions and shall be such as to prevent uncontrolled cracking of the pavement. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit cutting the concrete without chipping, spalling, or tearing. The sawed faces of joints will be inspected for undercutting or washing of the concrete due to the early sawing, and sawing shall be delayed if undercutting is sufficiently deep to cause structural weakness or excessive roughness in the joint. The sawing operation shall be carried on as required during both day and night regardless of weather conditions. The joints shall be sawed at the required spacing consecutively in the sequence of the concrete placement. A chalk line or other suitable guide shall be used to mark the alinement of the joint. Before sawing a joint, the concrete shall be examined closely for cracks, and the joint shall not be sawed if a crack has occurred near the planned joint location. Sawing shall be discontinued when a crack develops ahead of the saw cut. Workmen and inspectors shall wear clean, rubber-soled footwear, and the number of persons walking on the pavement shall be limited to those actually performing the sawing operation. Immediately after the joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly flushed with water until all waste from sawing is removed from the joint. The surface shall be resprayed with curing compound as soon as free water disappears. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, but that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed with cord, backer rod, or other approved material before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period and shall prevent infiltration of foreign material until removed immediately before sawing joint sealant reservoir. The sawing equipment shall be adequate in the number of units and the power to complete the sawing at the required rate. An ample supply of saw blades shall be available on the job before concrete placement is started and at all times during sawing. At least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operation.

3.8.6.2 Insert-Type Joints

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NOTE: Delete this paragraph when this type of joint is not required. Do not use for Air Force pavements.
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Insert-type contraction joints shall be constructed by installing a preformed insert in the plastic concrete to form a weakened plane to induce cracking. Inserts shall be designed and constructed so that material in the area of the joint sealant reservoir can be removed by sawing or by simply lifting out. No metal inserts of any kind shall be used. Material forming the weakened plane below the joint sealant reservoir shall be left in place. Each type of insert shall be approved before installation. Inserts shall be furnished in proper dimensions for the various depths of joints shown and in lengths equal to the width of the paving lane. Insert type joints [shall] [shall not] be used for slipformed pavements.

a. Equipment. Inserts shall be installed using a machine equipped with a vibrating bar for cutting a groove in the plastic concrete for placement of the insert or for vibrating the insert into place at the prescribed joint location. Vibration units shall be arranged so that the vibration will be uniformly distributed throughout the bar. The intensity of vibration shall be adjustable as necessary to form a groove of proper size for the filler or for forcing the insert into the plastic concrete and consolidating the concrete around the in-place insert. [For concrete placed by slipform pavers, the edges of the plastic concrete shall be supported to prevent slumping during the vibration and placement of inserts.]

b. Installation of Inserts. The insert shall be installed in the plastic concrete immediately following the final machine finishing with a maximum of two joint spacings between the finishing machine and the inserter. Additional straightedge and texturing operations shall be accomplished without disturbing the installed insert. Installation of the insert shall be to the required depth throughout the full width of the paving lane. Adjacent sections of the joint inserts within each slab unit shall be securely joined together, and the insert shall extend across the full width of the slab. The concrete shall be thoroughly consolidated against and for the full depth of the insert. The installed insert shall be perpendicular to the finished grade of the pavement and shall be straight in alinement at the prescribed joint locations shown, with the top of the insert flush or not more than 1/8 inch below the pavement surface. The insert equipment shall be available on the job in good condition before placement of concrete.

c. Sawing or Removing Inserts. After the expiration of the curing period, a groove for the joint sealer shall be formed as specified below. The top portion of fiberboard fillers and other sawable preformed inserts shall be removed by sawing with a power saw to form a groove of required dimensions. The sawing shall be so accomplished as to abrade the concrete surfaces in the joint groove and remove all traces of the filler or insert. Nonsawable insert materials shall be removed as prescribed by the manufacturer. The dimensions and characteristics of the groove thus formed shall be as shown. The grooves shall have edges free of ravels and spalls.

3.8.7 Thickened Edge Joints

Thickened edge joints shall be constructed as indicated on the drawings. Underlying material in the transition area shall be graded as shown and shall meet the requirements for smoothness and compaction specified for all other areas of the underlying material.

3.8.8 Special Joints

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NOTE: Delete this paragraph if no such joints are shown.

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"Special joints" (undercut joints) shall be constructed adjacent to existing pavement as indicated. The concrete under the edge of the existing pavement and the concrete below the normal level of the bottom of the new pavement shall be placed as a separate operation in front of the paving train. The concrete shall be worked under the edge of the existing pavement to completely fill the void and shall be thoroughly consolidated by the use of hand-held vibrators. Timing shall be such that this concrete is still workable when the paving train goes across it. In no case shall this concrete be placed as part of the operation of the paving equipment.

3.8.9 Sealing Joints

Joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit. [Sawing or other removal of filler type joint formers shall be accomplished immediately before sealing of the joints.] Joints shall be sealed as specified in Section [02760FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS] [02762COMPRESSION JOINT SEALS FOR CONCRETE PAVEMENTS].

3.9 REPAIR, REMOVAL, REPLACEMENT OF SLABS

3.9.1 General Criteria

New pavement slabs that are broken or contain cracks shall be removed and replaced or repaired, as specified hereinafter at no cost to the Government. Spalls along joints shall be repaired as specified. Where removal of partial slabs is permitted, as specified, removal and replacement shall be full depth, shall be full width of the paving lane, and the limit of removal shall be normal to the paving lane and not less than 10 feet from each original transverse joint (i.e., removal portion shall be at least 10 feet longitudinally, and portion to remain in place shall be at least longitudinally; thus, if original slab length is less than 20 feet, the entire slab shall be removed). The Contracting Officer will determine whether cracks extend full depth of the pavement and may require cores to be drilled on the crack to determine depth of cracking. Such cores shall be at least 6 inch diameter, shall be drilled by the Contractor and shall be filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with epoxy resin, using approved procedures. Drilling of cores and refilling holes shall be at no expense to the Government. All epoxy resin used in this work shall conform to paragraph EPOXY RESIN, Type and Grade as specified.

3.9.2 Slabs with Cracks Thru Interior Areas

Interior area is defined as that area more than 24 inchesfrom either adjacent original transverse joint. Slabs with any cracks that extend into the interior area, regardless of direction, shall be treated by one of the following procedures.

3.9.2.1 Cracks That Do Not Extend Full Depth of Slab

These cracks, and similar cracks within the areas 24 incheseach side of transverse joints, shall be cleaned and then pressure injected with epoxy resin, Type IV, Grade 1, using procedures as approved. The procedure shall not widen the crack during epoxy resin injection. All epoxy resin injection shall take place in the presence of a representative of the Contracting Officer.

3.9.2.2 Cracks That Extend Full Depth of Slab

Where there is any full depth crack at any place within the interior area, the full slab shall be removed. However, if the cracked area all lies within 10 feet of one original transverse joint, only a partial slab need be removed provided all criteria specified above for distance from each original transverse joint is met.

3.9.3 Cracks close to and Parallel to Transverse Joints

All cracks essentially parallel to original transverse joints, extending full depth of the slab, and lying wholly within 24 incheseither side of the joint shall be treated as specified hereinafter. Any crack extending more than 24 inches from the transverse joint shall be treated as specified above for Slabs With Cracks Through Interior Areas. Any cracks which do not extend full depth of the slab shall be treated as specified above in subparagraph, Cracks That Do Not Extend Full Depth Of Slab, and the original transverse joint constructed as originally designed.

3.9.3.1 Full Depth Cracks Present, Original Joint Not Opened

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NOTE: Allow use of a saw for cracks only if experience in the area has shown satisfactory results. Otherwise edit this paragraph accordingly.
****

When the original transverse joint has not opened, the crack shall be routed and sealed, and the original transverse joint filled with epoxy resin. The crack shall be routed with an easily guided, wheel mounted, vertical shaft, powered rotary router designed so the routing spindle will caster as it moves along the crack, or with a small diameter saw designed for this use. The reservoir for joint sealant in the crack shall be formed by routing to a depth of 3/4 inch,plus or minus 1/16 inch, and to a width of 5/8 inch, plus or minus 1/8 inch. Any equipment or procedure which causes ravelling or spalling along the crack shall be modified or replaced to prevent such ravelling or spalling. The joint sealant shall be a liquid sealant as specified for rigid pavement joints. Installation of joint seal shall be as specified for sealing joints or as directed. The uncracked transverse joint shall be filled with epoxy resin. If the joint sealant reservoir has been sawed out, the reservoir and as much of the lower saw cut as possible shall be filled with epoxy resin, Type IV, Grade 2, thoroughly tooled into the void using approved procedures. If only the original narrow saw cut has been made, it shall be cleaned and pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. If filler material (joint insert) has been used to form a weakened plane in the transverse joint, it shall be completely sawed out and the saw cut pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. Where a parallel crack goes part way across the paving lane and then intersects and follows the original transverse joint which is cracked only for the remainder of the width, it shall be treated as follows: The area with the separate crack shall be treated as specified above for a parallel crack, and the cracked original joint shall be prepared and sealed as originally designed.

3.9.3.2 Full Depth Cracks, Original Joint Also Cracked

At a transverse joint, if there is any place in the lane width where a parallel crack and a cracked portion of the original joint overlap, a section of the slab containing the crack shall be removed and replaced for the full lane width and at least 10 feet long. If this partial slab removal places the limit of removal less than 10 feet from the next transverse joint, the entire slab shall be removed. If the parallel crack crosses the transverse joint line, a similar area shall be removed and replaced in both slabs.

3.9.4 Removal and Replacement of Full Slabs

Where it is necessary to remove full slabs, unless there are keys or dowels present, all edges of the slab shall be cut full depth with a concrete saw. All saw cuts shall be perpendicular to the slab surface. If keys, dowels, or tie bars are present along any edges, these edges shall be sawed full depth 6 inches from the edge if only keys are present, or just beyond the end of dowels or tie bars if they are present. These joints shall then be carefully sawed on the joint line to within 1 inch of the depth of the dowel or key. The main slab shall be further divided by sawing full depth, at appropriate locations, and each piece lifted out and removed. Suitable equipment shall be used to provide a truly vertical lift, and approved safe lifting devices used for attachment to the slabs. The narrow strips along keyed or doweled edges shall be carefully broken up and removed using light, hand-held jackhammers, 30 lb or less, or other approved similar equipment. Care shall be taken to prevent damage to the dowels, tie bars, or keys or to concrete to remain in place. The joint face below keys or dowels shall be suitably trimmed so that there is no abrupt offset in any direction greater than 1/2 inch and no gradual offset greater than 1 inch when tested in a horizontal direction with a straightedge. No mechanical impact breakers, other than the above hand-held equipment shall be used for any removal of slabs. If underbreak between 1-1/2 and 4 inches deep occurs at any point along any edge, the area shall be repaired as directed before replacing the removed slab. Procedures directed will be similar to those specified for surface spalls, modified as necessary. If underbreak over 4 inches deep occurs, the entire slab containing the underbreak shall be removed and replaced. Where there are no dowels, tie bars, or keys on an edge, or where they have been damaged, dowels of the size and spacing as specified for other joints in similar pavement shall be installed by epoxy grouting them into holes drilled into the existing concrete using procedures as specified in paragraph, Placing Dowels and Tie Bars. Original damaged dowels or tie bars shall be cut off flush with the joint face. Protruding portions of dowels shall be painted and lightly oiled. All four edges of the new slab shall thus contain dowels or original keys or original tie bars. Placement of concrete shall be as specified for original construction. Prior to placement of new concrete, the underlying material shall be recompacted and shaped as specified in the appropriate section of these specifications, and the surfaces of all four joint faces shall be cleaned of all loose material and contaminants and coated with a double application of membrane forming curing compound as bond breaker. Care shall be taken to prevent any curing compound from contacting dowels or tie bars. The resulting joints around the new slab shall be prepared and sealed as specified for original construction.

3.9.5 Removal and Replacement of Partial Slabs

Where the above criteria permits removal of partial slabs, removal and replacement operations shall be as specified for full slabs, except that the joint between the removed area and the partial slab to remain in place shall consist of a full depth saw cut across the full lane width and perpendicular to the centerline of the paving lane. Replacement operations shall be the same as specified above, except that, at the joint between the removed area and the partial slab to remain, deformed tie bars shall be epoxy resin grouted into holes drilled into the slab to remain in place. Size and spacing of the tie bars shall be as specified for dowels. Drilling of holes and installation of tie bars shall be as specified for dowels in paragraph, Placing Dowels and Tie Bars, except that no portion of the tie bars shall be painted or oiled. No curing compound shall be used on this joint face and, immediately before placing new concrete, the joint surface of the partial slab remaining in place shall be coated with epoxy resin, Type V, Grade 2.

3.9.6 Repairing Spalls Along Joints

Where directed, spalls along joints of new slabs, along edges of adjacent existing concrete, and along parallel cracks shall be repaired by first making a vertical saw cut at least 1 inch outside the spalled area and to a depth of at least 2 inches. Saw cuts shall be straight lines forming rectangular areas. The concrete between the saw cut and the joint, or crack, shall be chipped out to remove all unsound concrete and at least a depth of 1/2 inch of visually sound concrete. The cavity thus formed shall be thoroughly cleaned with high pressure water jets supplemented with compressed air to remove all loose material. Immediately before filling the cavity, a prime coat shall be applied to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. The prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff-bristle brush. Prime coat for portland cement repairs shall be a neat cement grout and for epoxy resin repairs shall be epoxy resin, Type III, Grade 1. The cavity shall be filled with low slump portland cement concrete or mortar or with epoxy resin concrete or mortar. Portland cement concrete shall be used for larger spalls, those more than 1/3 cu. ft. in size after removal operations; portland cement mortar shall be used for spalls between 0.03 cu. ft. and 1/3 cu. ft.; and epoxy resin mortar or Type III, Grade 3 epoxy resin for those spalls less than 0.03 cu. ft.in size after removal operations. Portland cement concretes and mortars shall be very low slump mixtures, 1/2 inch slump or less, proportioned, mixed, placed, consolidated by tamping, and cured, all as directed. [If the materials and procedures are approved in writing, latex modified concrete mixtures may be used for repairing spalls less than 1/3 cu.ft. in size.] Epoxy resin mortars shall be made with Type III, Grade 1, epoxy resin, using proportions and mixing and placing procedures as recommended by the manufacturer and approved by the Contracting Officer. The epoxy resin materials shall be placed in the cavity in layers not over 2 inches thick. The time interval between placement of additional layers shall be such that the temperature of the epoxy resin material does not exceed 140 degrees F at any time during hardening. Mechanical vibrators and hand tampers shall be used to consolidate the concrete or mortar. Any repair material on the surrounding surfaces of the existing concrete shall be removed before it hardens. Where the spalled area abuts a joint, an insert or other bond-breaking medium shall be used to prevent bond at the joint face. A reservoir for the joint sealant shall be sawed to the dimensions required for other joints, or as required to be routed for cracks. The reservoir shall be thoroughly cleaned and then sealed with the sealer specified for the joints. If any spall penetrates half the depth of the slab or more, the entire slab, or 10 foot portion thereof, shall be removed and replaced as previously specified. [In lieu of sawing, spalls not adjacent to joints, and popouts, both less than 6 inches in maximum dimension, may be prepared by drilling a core 2 inches in diameter greater than the size of the defect, centered over the defect, and 2 inches deep or 1/2 inch into sound concrete, whichever is greater. The core hole shall be repaired as specified above for other spalls.]

3.10 EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR

****
NOTE: It is imperative that sufficient exploration be made (not just reference to as-built drawings) for the designer to know exactly what the in-place existing pavement is at the jointing area--dowels, keys, tie bars, etc--and its condition. Normally, the joint between the new pavement and existing pavement should be made at an existing joint in the old pavement.
****

Existing concrete pavement shall be removed as indicated and as specified in Section 02220 DEMOLITION, modified, and expanded as specified herein. Repairs shall be made as indicated and as specified herein. All operations shall be carefully controlled to prevent damage to the concrete pavement and to the underlying material to remain in place. All saw cuts shall be made perpendicular to the slab surface, and forming rectangular areas.

3.10.1 Removal of Existing Pavement Slab

****
NOTE: Edit bracketed items concerning dowels and keys to conform to the design used. The best results are usually with a design requiring that keys and dowels be sawed off and new dowels installed in drilled holes. The saw cut at a distance from the joint should be sawed with a wheel saw which produces a 38 mm (1-1/2 inch) or wider kerf and better prevents stress from propagating across the saw cut.
****

When existing concrete pavement is to be removed and adjacent concrete is to be left in place, the joint between the removal area and adjoining pavement to stay in place [, including dowels, tie bars or keys,] shall first be cut full depth with a standard diamond-type concrete saw. [If keys or dowels are present at this joint, the saw cut shall be made full depth at 6 inches from the joint if only keys are present, or just beyond the end of dowels if dowels are present. The edge shall then be carefully sawed on the joint line to within 1 inch of the top of the dowel or key.] Next, a full depth saw cut shall be made parallel to the joint at least 24 inches from the joint and at least 6 inches from the end of any dowels. This saw cut shall be made with a wheel saw as specified in paragraph SAWING EQUIPMENT. All pavement to be removed beyond this last saw cut shall be removed using equipment and procedures specified in Section 02220 DEMOLITION and as approved. All pavement between this last saw cut and the joint line shall be removed by carefully pulling pieces and blocks away from the joint face with suitable equipment and then picking them up for removal. In lieu of this method, this strip of concrete may be carefully broken up and removed using hand-held jackhammers, 30 lb or less, or other approved light-duty equipment which will not cause stress to propagate across the joint saw cut and cause distress in the pavement which is to remain in place. In lieu of the above specified removal method, the slab may be sawcut full depth to divide it into several pieces and each piece lifted out and removed. Suitable equipment shall be used to provide a truly vertical lift, and safe lifting devices used for attachment to the slab. [Where dowels or keys are present, care shall be taken to produce an even, vertical joint face below the dowels or keys. This joint face shall be trimmed so that there is no abrupt offset in any direction greater than 1/2 inch and no gradual offset greater than 1 inch when tested in a horizontal direction with a straightedge. If the Contractor is unable to produce such a joint face, or if underbreak or other distress occurs, the Contractor shall saw the dowels or keys flush with the joint. The Contractor shall then install new dowels, of the size and spacing used for other similar joints, by epoxy resin bonding them in holes drilled in the joint face as specified in paragraph, Placing dowels and Tie-bars. All this shall be at no additional cost to the Government.] [Dowels of the size and spacing indicated shall be installed as shown on the drawings by epoxy resin bonding them in holes drilled in the joint face as specified in paragraph, Placing Dowels and Tie Bars.]

3.10.2 Edge Repair

****
NOTE: Edit bracketed items on payment as appropriate.
****

The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Areas which are damaged during construction shall be repaired at no cost to the Government; repair of previously existing damage areas [will be paid for as listed in the bid schedule] [will be considered a subsidiary part of concrete pavement construction].

3.10.2.1 Spall Repair

Spalls along joints and along cracks shall be repaired where indicated and where directed. Repair materials and procedures shall be as previously specified in subparagraph, Repairing Spalls Along Joints.

3.10.2.2 Underbreak Repair

All underbreak shall be repaired. First, all delaminated and loose material shall be carefully removed. Next, the underlying material shall be recompacted, without addition of any new material. Finally, the void shall be completely hand-filled with paving concrete mixture, thoroughly consolidated. Care shall be taken to produce an even joint face from top to bottom. Prior to placing concrete, the underlying material shall be thoroughly moistened. After placement, the exposed surface shall be heavily coated with curing compound. All this shall be done at least 24 hours before placing the new paving concrete against the joint.

3.10.2.3 Underlying Material

The underlying material adjacent to the edge of and under the existing pavement which is to remain in place shall be protected from damage or disturbance during removal operations and until placement of new concrete, and shall be shaped as shown on the drawings or as directed. Sufficient underling material shall be kept in place outside the joint line to completely prevent disturbance of material under the pavement which is to remain in place. Any material under the portion of the concrete pavement to remain in place which is disturbed or loses its compaction shall be carefully removed and replaced with concrete as specified above under

Underbreak Repair. The underlying material outside the joint line shall be thoroughly compacted and shall be moist when new concrete is placed.

3.11 PAVEMENT PROTECTION

The Contractor shall protect the pavement against all damage prior to final acceptance of the work by the Government. Aggregates rubble, or other similar construction materials shall not be piled on airfield pavements. Traffic shall be excluded from the new pavement by erecting and maintaining barricades and signs until the concrete is at least 14 days old, or for a longer period if so directed. As a construction expedient in paving intermediate lanes between newly paved pilot lanes, operation of the hauling equipment will be permitted on the new pavement after the pavement has been cured for 7 days and the joints have been sealed or otherwise protected. Also, the subgrade planer, concrete paving and finishing machines, and similar equipment may be permitted to ride upon the edges of previously constructed slabs when the concrete has attained a minimum flexural strength of 400 psi and approved means are furnished to prevent damage to the slab edge. All new and existing pavement carrying construction traffic or equipment shall be continuously kept completely clean, and spillage of concrete or other materials shall be cleaned up immediately upon occurrence. Special care shall be used where Contractor's traffic uses or crosses active airfield pavement. In these areas, if necessary in order to accomplish this, full-time workmen with hand brooms shall be used at anytime there is traffic. Other existing pavements used by the Contractor shall be power broomed at least daily when traffic operates. For fill-in lanes, equipment shall be used that will not damage or spall the edges or joints of the previously constructed pavement.

3.12 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL

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NOTE: For non-critical small projects, less than 600 cubic meters (750 cu. yd.) of the concrete, the designer may reduce, but not eliminate, the requirements of these paragraphs, and should edit them appropriately for the project specifications.

****

3.12.1 Testing and Inspection by Contractor

The Contractor shall perform the inspection and tests described below, and based upon the results of these inspections and tests, shall take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the paving operation is out of control, concrete placement shall cease. The laboratory performing the tests shall be on-site and shall conform with ASTM C 1077. The individuals who sample and test concrete or the constituents of concrete as required in this specification shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I. The individuals who perform the inspection of concrete shall have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of Concrete Construction Inspector, Level II. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C 1077. This testing shall be performed by the Contractor regardless of any other testing performed by the Government, either for pay adjustment purposes or for any other reason.

3.12.2 Testing and Inspection Requirements

3.12.2.1 Fine Aggregate

a. Grading. At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C 136 and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits.

b. Corrective Action for Fine Aggregate Grading. When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall be immediately reported to the Contracting Officer, paving shall be stopped, and immediate steps taken to correct the grading.

3.12.2.2 Coarse Aggregate

a. Grading. At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt approved limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling.

b. Corrective Action for Grading. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer, and steps taken to correct the grading. Where two consecutive averages of 5 tests are outside specification limits, the operation shall be considered out of control and shall be reported to the Contracting Officer, paving shall be stopped, and immediate steps shall be taken to correct the grading.

3.12.2.3 Quality of Aggregates

Thirty days prior to the start of concrete placement, the Contractor shall perform all tests specified for aggregate quality, including deleterious materials. In addition, after the start of paving, the Contractor shall perform similar tests for aggregate quality at least once every month, and when the source of aggregate or aggregate quality changes. Testing interval may be increased to three months when the previous two tests indicate the aggregate meets all quality requirements. Samples tested after the start of concrete placement shall be taken immediately prior to entering the concrete mixer.

3.12.2.4   Scales, Batching and Recording

a. Weighing Accuracy. The accuracy of the scales shall be checked by test weights prior to start of concrete operations and at least once every month for conformance with specified requirements. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

b. Batching and Recording Accuracy. Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required mass, recorded mass, and the actual mass batched. The Contractor shall test and ensure that the devices for dispensing admixtures are operating properly and accurately.

c. Corrective Action. When either the weighing accuracy or batching accuracy does not comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

3.12.2.5   Batch-Plant Control

The measurement of all constituent materials including cementitious materials, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate masses and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. The amount of air-entraining agent shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water masses per cubic yard,amount of water as free moisture in each size of aggregate, and the batch aggregate and water masses per cubic yard for each class of concrete batched during each day's plant operation.

3.12.2.6   Concrete Mixture

a. Air Content Testing. Air content tests shall be made when test specimens are fabricated. In addition, at least two other tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of paving. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Tests shall be made in accordance with ASTM C 231. Test results shall be plotted on control charts which are kept current and shall, at all times, be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single test result reaches either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the air content of the batch to plot on both the air content and the control chart for range, and for determining need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate control chart for each mixture on which an average line is set at the midpoint of the specified air content range from paragraph SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES. An upper warning limit and a lower warning limit line shall be set 1.0 percentage point above and below the average line, respectively. An upper action limit and a lower action limit line shall be set 1.5 percentage points above and below the average line, respectively. The range between each two consecutive tests shall be plotted on a secondary control chart for range where an upper warning limit is set at 2.0 percentage points and an upper action limit is set at 3.0 percentage points. Samples for air content shall be taken at the paving site. The Contractor shall deliver the concrete to the paving site at the stipulated air content. If the Contractor's materials or transportation methods cause air content loss between the mixer and the paving site, correlation samples shall be taken at the paving site as required by the Contracting Officer, and the air content at the mixer controlled as directed.

b. Air Content Corrective Action. Whenever points on the control chart for percent air reach either warning limit, an adjustment shall immediately be made in the amount of air-entraining admixture batched. As soon as practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the secondary control chart for range reaches the warning limit, the admixture dispenser shall be recalibrated to insure that it is operating accurately and with good reproducibility. Whenever a point on either control chart (single test or result of two tests made concurrently, as specified above) reaches an action limit line, the air content shall be considered out of control and the paving operation shall immediately be halted until the air content is under control. Additional air content tests shall be made when paving is restarted.

c. Slump Testing. Slump tests shall be made when test specimens are fabricated. In addition, at least four other slump tests shall be made on randomly selected batches in accordance with ASTM C 143 for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single slump test reaches or goes beyond the upper action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the slump of the batch to plot on both the control chart for slump and the chart for range, and for determining need for any remedial action. An upper warning limit shall be set at 1/2 inch below the maximum allowable slump on separate control charts for slump used for each type of mixture as specified in paragraph, SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES, and an upper action limit line shall be set at the maximum allowable slump, as specified in the same paragraph for fixed form paving or as selected by the Contractor at the start of the project for slipform paving. The range between each consecutive slump test for each type of mixture shall be plotted on a single control chart for range on which an upper action limit is set at 1-1/2 inches. Samples for slump shall be taken at the paving site. The Contractor is responsible for delivering the concrete to the paving site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between the mixer and the paving site, correlation samples shall be taken at the paving site as required by the Contracting Officer, and the slump at the mixer controlled as directed.

d. Slump Corrective Action. Whenever points on the control charts for slump reach the upper warning limit, an approved adjustment shall immediately be made in the batch masses of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount allowed by the maximum w/c specified, based on aggregates which are in a saturated surface dry condition. When a slump result (average of two tests made concurrently, as specified above) exceeds the upper action limit, no further concrete shall be delivered to the paving site until proper adjustments have been made. Immediately after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive individual slump tests, made during a period when there was no adjustment of batch masses, produce a point on the control chart for range at or above the upper action limit, the paving operation shall immediately be halted, and the Contractor shall take approved steps to bring the slump under control. Additional slump tests shall be made as directed.

e. Temperature. The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064. The temperature shall be reported along with the compressive strength data.

3.12.2.7 Concrete Strength Testing for CQC

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NOTE: If paragraph Flexural Strength and Thickness is based on 28-day flexural strength for acceptance, modify this subparagraph to match it. Modify this subparagraph as appropriate if the Government is responsible for mixture proportions.

****

Contractor Quality Control operations for concrete strength shall consist of the following steps:

a. Take samples for strength tests at the paving site. Fabricate and cure test cylinders in accordance with ASTM C 31/C 31M; test them in accordance with ASTM C 39.

b. Fabricate and cure 2 test cylinders per sublot from the same batch or truckload and at the same time acceptance cylinders are fabricated and test them for compressive strength at 7-day age.

c. Average all 8 compressive tests per lot. Convert this average 7-day compressive strength per lot to equivalent 90-day flexural strength using the Correlation Ratio determined during mixture proportioning studies.

d. Compare the equivalent 90-day flexural strength from the conversion to the Average Flexural Strength Required for Mixtures from paragraph of same title.

e. If the equivalent average 90-day strength for the lot is below the Average Flexural Strength Required for Mixtures by 20 psiflexural strength or more, at any time, adjust the mixture to increase the strength, as approved.

f. If the equivalent average 90-day strength is above the Average Flexural Strength Required for Mixtures by 20 psi flexural strength or more for 2 consecutive days, the Contractor will be permitted to adjust the mixture to decrease the strength, as approved.

g. The Contractor's CQC testing agency shall maintain up-to-date control charts for strength, showing the 7-day CQC compressive strength, the 14-day compressive strength (from acceptance tests) and the 90-day equivalent flexural strength of each of these for each lot.

3.12.2.8 Inspection Before Placing

Underlying materials, construction joint faces, forms, reinforcing, dowels, and embedded items shall be inspected by the Contractor in sufficient time prior to each paving operation in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

3.12.2.9 Paving

a. Paving Inspection. The placing foreman shall supervise all placing and paving operations, shall determine that the correct quality of concrete is placed in each location as shown and that finishing is performed as specified; shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume of concrete placed, and method of paving and any problems encountered.

b. Placing and Paving Corrective Action. The paving foreman shall not permit batching and paving to begin until it has been verified that an adequate number of vibrators in working order and with competent operators are available. Paving shall not be continued if piles of concrete exist or if the concrete is inadequately consolidated or if surface finish is not satisfactory. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

3.12.2.10 Vibrators

a. Vibrator Testing and Use. The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior to initial use and at least once a month when paving is in progress. Additional tests shall be made as directed when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head, and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing.

b. Vibrator Corrective Action. Any vibrator not meeting the requirements of subparagraphs, Paver-Finisher and Consolidation, shall be immediately removed from service and repaired or replaced.

3.12.2.11 Curing Inspection

a. Moist Curing Inspections. At least twice each shift, and not less than four times per day (never more than 7 hours apart) on both work and non-work days, an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.

b. Moist Curing Corrective Action. When any inspection finds an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for the area shall be extended by 1 day.

c. Membrane Curing Inspection. No curing compound shall be applied until the Contractor has verified that the compound is properly mixed and ready for spraying. At the end of each day's operation, the quantity of compound used shall be determined by measurement of the container and the area of concrete surface covered; the Contractor shall then compute the rate of coverage in square feet per gallon and shall also note whether or not coverage is uniform. All this shall be reported daily.

d. Membrane Curing Corrective Action. When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.

e. Sheet Curing Inspection. At least once each shift and once per day on non-work days, an inspection shall be made of all areas being cured using impervious sheets. The condition of the covering and the tightness of the laps and tapes shall be noted and recorded.

f. Sheet Curing Corrective Action. When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, the tears and holes shall promptly be repaired or the sheets replaced, the joints closed, and the required curing period for those areas shall be extended by 1 day.

3.12.2.12 Cold-Weather Protection

At least once each shift and once per day on non-work days, an inspection shall be made of all areas subject to cold-weather protection. Any deficiencies shall be noted, corrected, and reported.

3.12.2.13 Mixer Uniformity

a. Stationary Mixers. Prior to the start of concrete placing and once every 4 months when concrete is being placed, or once for every 50,000 cubic yards of concrete placed, whichever results in the longest time interval, uniformity of concrete mixing shall be determined in accordance with COE CRD-C 55. The original test shall be a Regular Test. After the mixing operation has been tested and approved, subsequent tests shall be Abbreviated Tests.

b. Truck Mixers. Prior to the start of concrete placing and at least once every 4 months when concrete is being placed, uniformity of concrete mixing shall be determined in accordance with ASTM C 94. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.

c. Mixer Uniformity Corrective Action. When a mixer fails to meet mixer uniformity requirements, either the mixing time shall be increased, batching sequence changed, batch size reduced, or adjustments shall be made to the mixer until compliance is achieved. After adjustments have been made, another uniformity test shall be made.

3.12.2.14 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

-- End of Section --

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Latest change indicated by CHG tags

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DEPARTMENT OF THE ARMY | **CEGS-02761 (November 1997)**
U.S. ARMY CORPS OF ENGINEERS | **-------------------------**
Superseding
CEGS-02584 (February 1991)

GUIDE SPECIFICATION FOR CONSTRUCTION
Includes Text Adjustment Chane (Section References) (November 1998)
Latest change indicated by CHG tags

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SECTION 02761

FUEL-RESISTANT SEALING
11/97

****

NOTE: This guide specification covers the requirements for fuel-resistant sealer for parking and maintenance areas. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 142	(1978; R 1990) Clay Lumps and Friable Particles in Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 466	(1942; R 1989) Films Deposited from Bituminous Emulsions
ASTM D 747	(1993) Apparent Bending Modulus of Plastics by Means of a Cantilever Beam
ASTM D 2939	(1994) Emulsified Bitumens Used as Protective Coatings
ASTM D 2983	(1987; R 1993) Low-Temperature Viscosity of Automotive Fluid Lubricants Measured by Brookfield Viscometer
ASTM D 2995	(1993) Determining Application Rate of Bituminous Distributors
ASTM D 3320	(1990) Emulsified Coal-Tar Pitch (Mineral Colloid Type)
ASTM D 3699	(1996a) Kerosine

1.2 UNIT PRICES

****

NOTE: Delete this paragraph when lump sum bidding is used.

****

1.2.1 Waybills and Delivery Tickets

Copies of waybills and delivery tickets shall be submitted during the progress of the work. Before the final statement is allowed, the Contractor shall submit certified waybills and delivery tickets for all materials used in the work covered by this section. The Contractor shall not remove remaining sealer materials from tank cars or storage tanks until measurements of the quantities used have been made.

1.2.2 Method of Measurement

****

NOTE: When other methods of measurement are desired or necessary, this paragraph will be modified accordingly.

****

Binder material, additional sealer material and aggregate to be paid for will be the measured quantities used in the accepted work.

1.2.2.1 Binder Material

The amount of binder material to be paid for will be measured by the number of gallons of the material used in the accepted work. The proper coefficient of volumetric expansion per degree F, as supplied by the manufacturer, shall be used for all binder volume calculations.

1.2.2.2 Additional Sealer Material

Additional sealer material includes any additives or modifiers added to the binder to form the sealer. The materials may be measured by volume or weight.

1.2.2.3 Aggregate

The amount of aggregate to be paid for will be the number of dry tons (2,000 pounds) placed and accepted in the completed work.

1.2.3 Payment

Quantities of sealer material and aggregate determined as specified will be paid for at the respective contract unit prices. Such payment will constitute full compensation for all operations necessary to complete the work as specified herein.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Mix Proportions; [_____].

A copy of the mixture proportions that meet all the requirements of this specification.

SD-09 Reports

Sealer Materials; GA.

Samples or certified test results of the materials, [_____] days prior to the beginning of work. No material will be allowed to be used until it has been approved.

1.4 EQUIPMENT

Machines, tools, and equipment used in the performance of the work will be approved before the work is started and shall be maintained in satisfactory condition.

1.4.1 Mixing

****

NOTE: The requirements for the mixing plants should be adjusted according to manufacturer's recommendations. The plant equipment listed may be deleted or added to as required. The water tank is required only when an emulsified binder is specified.

****

Mixing machines for preparing the slurry may be central plant mixers, or truck-mounted batch mixers of a type approved by the Contracting Officer, capable of producing a uniform mixture of sealer and aggregate. All mixing plants shall be equipped with [water tank,] agitated binder tank, aggregate hopper, appropriate pumps, conveyor belts, and controls as required. The mixers shall have suitable mixing blades to combine the predetermined quantities of materials into a homogeneous slurry.

1.4.2 Applicator

****

NOTE: Based upon the condition of the pavement prior to sealing, a decision must be made to either apply the sealer by spraying or by squeegeeing. Manufacturer's recommendations should also be followed when determining application methods. The spraying method should be used only on pavements that are in good condition, with minor, or no cracks. The squeegee method should be used on all other pavements. Delete the requirement for fogging the pavement surface where an emulsion binder is not used or where fogging is not part of the manufacturer's recommended procedure. Surface texture of the fresh sealer may be affected by (1) the condition of the flexible lining of the spreader box or (2) fragments of cured sealer adhering to the edges of the lining or to the squeegee. Worn linings will result in an uneven thickness. Fragments of cured seal or large aggregate particles caught in the lining will produce gouges and streaks. The sealer mixture should be checked for lumps or balling, which can be caused by inadequate mixing or premature cure of the sealer. Deviation of the aggregate from the specified gradation will also result in an unsatisfactory product. The minimum coating thickness for the aggregate gradation specified would be approximately 1.36 liters per square meter (0.30 gallons per square

yard). This paragraph may have to be amended depending on the type of binder used and the manufacturer's recommendations.

Delete within the brackets as required. Except where prohibited by manufacturer's recommendations, a minimum of two coats of sealer mixture should be used to ensure a complete coverage or seal. The 1.58 liters per square meter (0.35 gallons per square yard) rate is the minimum amount of material that can be applied by squeegee with the gradation given in TABLE 2. The residual material of each coating will be affected by the amount of solids versus the amount of volatiles in the sealer mixture. The amount of residual material applied can be determined by knowing the components of the sealer, the amount applied, and the area covered. The amount of sealer applied by spraying should be similar to that provided by squeegee methods. When sand is added in amounts greater than 0.24 kg per liter (2 pounds per gallon) of residual binder, a final coating of sealer without sand is required to achieve a fuel resistant surface. Seals with 0.24 kg (2 pounds) of sand or less per liter (gallon) of residual binder, will not require a final plain coating. Where high sand loadings are used (greater than 0.24 kg (2 pounds)) the useful life (fuel resistance) of the sealer will be limited to the time that this last coating seals the surface. Higher sand loadings are required on asphalt pavements that have cracks; the larger the crack, the more sand necessary to fill the voids. Cracks 10 mm (3/8 inch) and wider should be presealed with sealer mixture. Sand should be added to the sealer to provide for a wearing and traction surface.

****

[A spreader box shall be attached to the delivery tank or portable mixing plant truck to place the slurry. The truck shall be provided with a water tank, pump, and spray bar for fogging the pavement surface ahead of the spreader box. A variable-width mechanical-type squeegee spreader box shall be attached to the sealer mixing machine. The spreader box shall be equipped and maintained with flexible material in contact with the pavement surface to prevent loss of seal mixture from the spreader box on varying grades and crown. The spreader box shall be capable of adjustments to ensure uniform spread. Where the spreader box is wider than 10 feet, it shall be equipped for lateral distribution of the sealer mixture within the spreader. The spreader box shall be kept clean, and buildup of sealer and aggregate on the squeegee and spreader box shall not be permitted.] [The spray vehicle may be either self-propelled or towed, designed and equipped to apply a uniform mixture of sealer and aggregate at rates ranging from 0.10 to 0.70 gallons per square yard. Sprayer equipment shall include a separate power unit, agitated tank, spray bar, hand spray wand, and suitable pump and plumbing for handling sealer and aggregate.]

1.4.3 Distributor

****
NOTE: This paragraph may be deleted where a spray vehicle is used for sealer application and can apply a tack coat, if required.
****

The distributor shall be self-propelled and shall be designed and equipped to distribute sealer uniformly on various surface widths at readily determined and controlled rates ranging from 0.05 to 0.5 gallons per square yard. Allowable variation from any specified rate shall not exceed 5 percent.

1.4.4 Cleaning Equipment

Cleaning equipment shall consist of power brooms, power blowers, power vacuums, air compressors, hand brooms, and other equipment as needed. The equipment shall be suitable for cleaning the surface and cracks in the existing pavement.

1.4.5 Hand Tools

Hand tools shall consist of hand squeegees, shovels, and other equipment as necessary to perform the work.

1.5 SAMPLING AND TESTING

1.5.1 Sampling

****
NOTE: Insert the appropriate sampling method where bituminous binders are not used. Follow manufacturer's recommendations.
****

Aggregate samples shall be furnished in accordance with ASTM D 75. Samples of binder, unless otherwise specified, shall be in accordance with ASTM D 140. Additional samples of materials shall be furnished as required.

1.5.2 Testing

****
NOTE: An approved testing laboratory is required to meet the testing requirements of this specification. The Contractor testing, when accepted, should only be used for quality control on the job and not for the initial mixture design.

Coordinate this paragraph with the specified requirements in paragraph Composition.
****

Materials shall be tested to establish compliance with the specified requirements. Quality control testing shall be performed by an approved commercial testing laboratory or by Contractor testing, subject to approval.

1.5.3 Calibration Test

****

NOTE: Calibration of all equipment used to place sealer will allow the Government to determine the application rate and thereby the total quantity of material placed per area of pavement.

****

Equipment, materials and labor shall be furnished as necessary to calibrate equipment used to place the sealer. Calibrations shall be made with the approved job materials prior to applying the sealer materials to the prepared surface.

1.5.3.1 Applicator

The equipment shall be calibrated to ensure that it will produce a sealed surface that complies with the requirements of this specification. All commercial equipment shall be provided with a method of calibration by the manufacturer.

1.5.3.2 Distributor

Calibration of the distributor shall be in accordance with ASTM D 2995. A copy of the calibration test results shall be submitted before the sealer distributor is used on the job.

1.5.4 Trial Application

Prior to applying the sealer mixture, a test section at least 100 feet long and 20 feet wide shall be placed by the Contractor using the approved materials and equipment. The sealer mixture shall be placed in accordance with the specified requirements. The rate of application shall be determined for compliance to specification requirements. If the test section does not conform to the specification requirements, necessary adjustments shall be made, and additional test sections shall be constructed for conformance to the specifications. Where test sections do not conform to the specification requirements, the sealer mixture shall be removed by milling, grinding, or another approved method. Test sections that conform to all specification requirements may become part of the sealed surface.

1.6 DELIVERY AND STORAGE

Materials delivered to the site shall be inspected for contamination and damage, unloaded, and stored with a minimum of handling. Aggregates shall be stockpiled to prevent segregation, contamination, or accumulation of excess moisture. Sealer materials shall be stored according to the manufacturer's recommendations. Materials determined by the Contracting Officer to be contaminated, segregated, damaged, or which fail to meet specification requirements shall be removed from the jobsite and replaced at no additional cost to the Government.

1.7 WEATHER LIMITATIONS

Sealer shall not be applied if air or pavement temperatures are below 50 degrees F or if there is any possibility that the sealer will freeze before it has cured, unless otherwise directed by the Contracting Officer. No sealer shall be placed when rain or other impending weather conditions will prevent proper curing of the sealer mixture.

PART 2 PRODUCTS

2.1 SEALER MATERIALS

****

NOTE: Insert the type of sealer to be used (coal-tar emulsion, rubber adhesive, etc.) and select or insert the materials as required within the spaces. Manufacturer's recommendations for proprietary products should be provided in this paragraph. Insert any precautions of use or handling of the material as provided by the manufacturer. The paragraphs are recommended for use with coal tar emulsion sealers and shall be deleted along with the applicable publications when another sealer material is used.

****

The [_____] sealer material shall meet the requirements as specified in TABLE 1 and in paragraph TEST METHODS. The [_____] and aggregate shall mix homogeneously to produce a mixture that adequately suspends the aggregate in the mix.

TABLE 1. PHYSICAL PROPERTIES OF SEALER MIXTURES

Property	Requirement	Referenced Test Method
Curing Time, firm set:	8 hours maximum	ASTM D 2939
Resistance to Heat:	No blistering, sagging or slipping	ASTM D 2939
Resistance to Water:	No blistering, loss of adhesion or tendency to re-emulsify*	ASTM D 466
Resistance to Kerosene:	No penetration or loss of adhesion	ASTM D 466
Stiffness:	Computed stiffness shall not increase more than 30 percent after 14 days of additional cure	ASTM D 747
Viscosity of Sealer: (all constituents added, excluding sand)	Viscosity shall be a minimum of 700 Brookfield viscosity at 23 degrees C	ASTM D 2983

*The requirement of tendency to re-emulsify pertains only to emulsified sealers.

2.1.1 Coal-Tar Pitch Emulsion

The base coal-tar pitch emulsion (mineral colloid type) shall meet the requirements of ASTM D 3320.

2.1.2 Latex Rubber Additive

The rubber shall be a copolymer latex containing 30-49 parts acrylonitrile and 70-51 parts butadiene with a minimum solids content of 40 percent. Silicone, as recommended by the latex rubber manufacturer, shall be added at 3 percent by volume of the rubber content.

2.1.3 Water

The water added to the sealer mixture shall be potable. The temperature of the water added during mixing shall be at least 50 degrees F. The pH of the water shall conform to the requirements of the coal tar emulsion manufacturer.

2.2 AGGREGATE

The aggregate shall be either a natural or manufactured angular aggregate and shall be composed of clean, hard, durable, uncoated particles free from clay and other objectionable material when tested in accordance with ASTM C 142. The aggregate shall meet the gradation in TABLE 2, when tested in accordance with ASTM C 136.

TABLE 2. AGGREGATE GRADATION

Sieve Size	Percent Passing
No. 16	100
No. 30	25-85
No. 50	2-10
No. 100	0-2

2.3 SEALER MIXTURE

2.3.1 Composition

****

NOTE: When available, Government laboratories should be used for mix design validation and/or quality assurance testing. A minimum of 45 days should be allowed for the initial testing. This can be adjusted from discussions with the testing laboratory.

****

The exact proportions of [binder,] [latex,] [water,] and aggregate to be used in the preparation of the seal shall be determined by laboratory mix design and shall be furnished by the Contractor from an approved laboratory, unless otherwise directed by the Contracting Officer.

2.3.2 Properties

The sealer mixture shall meet all the applicable requirements as outlined in TABLE 1.

2.4 TEST METHODS

Unless specified otherwise, material preparation and testing shall occur at normal laboratory conditions of 73.4 plus or minus 3.6 degrees F and at 50 plus or minus 5 percent relative humidity.

2.4.1 Curing Time

****

NOTE: Insert the curing time according to the manufacturer's recommendations; normally 8 hours is required for coal tar emulsion.

****

Curing time shall be determined in accordance with paragraph 13 (Drying Time) of ASTM D 2939, except as noted. The sealer shall be cured for [_____] hours. In preparing the specimens, the mask may remain in place until sealer has set.

2.4.2 Resistance to Heat

Resistance to heat shall be determined in accordance with paragraph 14 (Resistance to Heat) of ASTM D 2939.

2.4.3 Resistance to Water

Resistance to water shall be determined in accordance with paragraphs 5 and 6 (Resistance to Water Action) of ASTM D 466 using distilled water.

2.4.4 Resistance to Kerosene

****

NOTE: When using a sealer other than coal tar, the kerosene must be colored to be visible in the tiles. The addition of a small amount of bituminous material (asphalt, motor oil, grease, etc.) to the kerosene will add sufficient color for this test.

****

Resistance to kerosene shall be determined in accordance with paragraphs 5 and 6 (Resistance to Water Action) of ASTM D 466, except the mixture shall be applied in [2] [3] coats. The residual material thickness accumulated on the tile shall be a minimum of 0.05 inch. Masks may be brass or plexiglass. Components of the sealer mixture shall be mixed according to the manufacturer's recommendations and applied in [2] [3] coats, using one mask for the first coat and 2 masks stacked together for the [second] [and third] coat. The masks shall be left in place for the initial drying period of each coat, usually 24 hours. The second mask shall be positioned on top of the first to pour the [second] [and third] coat. The initial 1/8-inchmask may be removed and replaced with a 1/4-inchmask to achieve the required 1/4-inch thickness. All coats shall be spread evenly with the top of the mask using a spatula or other straightedge. [Both coatings shall contain sealer and the desired aggregate content.] [The first 2 coats shall contain sealer and the desired sand content while the final coat shall contain only plain sealer.] Each coat shall be cured for 96 hours. After curing the final coat, the metal ring shall be sealed to the surface with a fuel-resistant adhesive material, such as silicone rubber sealant. The metal ring shall be filled with kerosene conforming to ASTM D 3699 for

24 hours. The kerosene shall then be removed from the ring and blotted dry from the sealer. Sealer shall be examined at normal laboratory conditions for softness and loss of adhesion. When the tile is broken in half, visible evidence of leakage or discoloration shall constitute failure of the tests.

2.4.5 Stiffness

****

NOTE: The stiffness test is used to eliminate binder materials which harden at a fast rate after application and quickly lose flexibility. The length of cure time shall be a minimum of 4 days for emulsified sealers. Follow manufacturer's recommendations for other types of sealers.

****

Sealer shall be tested in accordance with ASTM D 747, except as noted. A total of 10 test specimens shall be cast in plastic or brass masks (molds) 1/8-inch thick, 1-inch wide, and 4-inches long. The masks shall be removed after the sealer has set and, if required, the edges shall be trimmed even. The sealer shall be prepared as for the previous tests; however, no sand shall be added. More than one coating may be applied in order to obtain a minimum thickness ratio of 1:15 (thickness to span). Span width of the test device can be set at either 1/2 or 1 inch but shall remain constant for all tests on a particular sealer. The completed test specimens shall be cured for [_____] days before testing. The average stiffness of 5 test specimens shall be reported for the initial testing. Five additional test specimens shall be tested 14 days after the initial tests. The change in stiffness shall be within the requirements of TABLE 1.

2.4.6 Viscosity

****

NOTE: This paragraph and the corresponding requirement in TABLE 1 may be deleted when aggregate will not be used in the sealer mixture. The viscosity requirement is intended as a method of providing a sealer mixture which can hold the aggregate in suspension until placement is completed.

****

Viscosity shall be determined in accordance with ASTM D 2983. The viscosity shall meet the requirements of TABLE 1.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

Prior to application of the sealer mixture, the existing pavement surface shall be cleaned and unsatisfactory areas shall be repaired. Failed pavement, base, subbase, or subgrade material shall be removed and replaced with new materials. Cracks in the surface not due to structural deficiencies shall be cleaned by blowing out with compressed air. Cracks larger than 3/8 inch wide shall be filled by squeegeeing in a mixture of aggregate and sealer. Cracks larger than 1/4 inchbut less than 3/8 inch in width shall be filled with sealer. The final surface of the filled cracks shall be flush to 1/8 inch below the pavement surface. Any excess materials shall be removed from the pavement surface.

3.1.1 Removal of Deleterious Material

****

NOTE: Traffic marking paint need not be removed from streets, roads, or parking areas unless the paint is loose and flaking off. Large painted areas such as those which occur on airfield pavements may have to be removed prior to applying the sealer mixture to obtain satisfactory bond to the pavement. If traffic paint removal is not required, the reference to traffic paint removal in this paragraph will be deleted. Asphalt pavements which are heavily saturated with oil or grease cannot be satisfactorily cleaned by scrubbing with detergents. Although a clean surface may be obtained, the oil and grease below the surface will migrate to the top and will bleed through the sealer mixture, or will cause the sealer mixture to lose bond to the pavement. Treating the surface of the pavement with shellac to increase bond prior to placing the sealer has been tried with varying degrees of success. Several manufacturers also sell products intended for this purpose. In general, full-depth replacement of contaminated asphalt pavement surfaces is the only reliable method of correction. This requirement for full-depth removal and replacement of asphalt cement can be placed in the main body of the specifications. The type of herbicide and method of application will depend upon factors such as type of plants to be destroyed, weather conditions, time restraints, etc. Previous local construction practices that were successful should be used as a guide.

****

All dust, dirt, oil, grease, fuel, loose or flaky traffic paint, vegetation, and other objectionable material shall be removed. Grease-contaminated and oil-contaminated areas shall be cleaned or removed and replaced with new bituminous pavement as directed by the Contracting Officer. All vegetation shall be removed, and these areas treated with a herbicide. The type of herbicide and method of application will require approval by the Contracting Officer.

3.1.2 Tack Coat Application

****

NOTE: Delete this paragraph where application of a tack coat is not part of the manufacturer's recommended procedure. A tack coat is recommended for all but new, untrafficked (except for miscellaneous traffic during construction), asphalt pavements. Emulsified binders may be thinned as recommended by the manufacturer.

****

The pavement surface shall be prepared as specified above and sprayed with a thin coat of bituminous material conforming to Section 02748BITUMINOUS TACK AND PRIME COATS.

3.1.3 Wetting Pavement Surface

****
NOTE: Eliminate this paragraph when the manufacturer recommends against it or when an emulsion is not used as the binder.
****

Immediately prior to application of the sealer mixture, the surface of the pavement and all crack faces shall be moistened with a fog spray of water from the spray bar on the sealer machine. No free water shall be on the surface of the pavement following the fog spray. The rate of application of the fog spray shall be adjusted during the day to suit pavement temperature, surface texture, humidity, and dryness of the pavement surface.

3.2 PREPARATION AND APPLICATION OF SEALER

3.2.1 Preparation

The sealer mixture shall be prepared in a suitable mixing plant, subject to approval by the Contracting Officer.

3.2.1.1 Mechanical

****
NOTE: Delete wording in the brackets when an emulsion is not used.
****

The sealer shall be mixed in a suitable plant as described in paragraph EQUIPMENT. The sealer mixture shall be of the desired consistency with no segregation when deposited on the surface of the pavement. No additional elements shall be added. The sealer mixture shall show no signs of uncoated aggregate, [or] segregation, [or premature breaking of emulsion] when applied to the pavement surface.

3.2.1.2 Hand Mixing

Where small amounts of sealer are required, making mechanical mixing uneconomical, mixing may be accomplished by hand. The preparation requirements are the same as given in the preceding paragraph for mechanical mixing.

3.2.2 Application

****
NOTE: This paragraph may have to be amended depending on the type of binder used and the manufacturer's recommendations. The number of coatings used in the test method will be the same as specified in this paragraph. These paragraphs should be coordinated for agreement. The cure requirement of 96 hours for each coating may be

reduced to 24 hours where nonemulsified sealers are used. Follow manufacturer's recommendations concerning cure.
****

[Sufficient quantities of the sealer mixture shall be fed into the spreader box to obtain a uniform and complete pavement coverage. The spreader box shall be operated at such a forward speed that the amount of sealer mixture in the spreader box shall remain essentially constant. The sealer shall be applied so that the minimum thickness will not be less than the maximum thickness of the largest aggregate in the mix. [Three coats shall be applied, the first 2] [Two coats shall be applied, 1] with sand at a minimum application rate of 0.35 gallons per square yard and a final coat of plain sealer applied at a rate to achieve a minimum residual application thickness of 0.01 inch. The final residual cumulative thickness of all coatings shall be a minimum of 0.05 inch. Each application shall be thoroughly cured before another application is placed. No oversized aggregate particles shall be allowed in the sealer mixture, and no buildup of cured sealer mixture shall be allowed to collect in the spreader box. Streaks shall not be left in the finished surface.] [Spraying equipment shall be operated to provide a total final coating with a minimum thickness equal to the maximum thickness of the largest aggregate in the mix. The sealer shall be applied in [_____] coatings at a rate of [_____] gallons per square yard, with an allowable variation in specified rate of not more than plus or minus 5 percent. Each coating shall be thoroughly cured before another coating is applied.]

3.2.2.1 Joints

Longitudinal joint between adjacent lanes shall have no visible overlaps, pinholes, or uncovered areas. Thick spots caused by overlapping shall be smoothed immediately with hand squeegees before the sealer mixture cures. Overlaps which occur at transverse joints shall also be smoothed before the sealer mixture cures, so that a uniform surface is obtained which contains no breaks or discontinuities. Joints should be made while the first coat is still workable. If fresh working is not possible, the previous coat must be cured sufficiently to support the spreader box.

3.2.2.2 Stability of Mixture

****
NOTE: Delete wording in the brackets when an emulsion is not used.
****

Sealer mixture shall possess sufficient stability so that segregation [or premature breaking of emulsion] in the spreader box does not occur. Mixture shall be homogeneous following mixing and spreading [, free of water or emulsion bleeding].

3.2.2.3 Hand Application

****
NOTE: Close attention should be given during hand squeegee spreading of an emulsion sealer mixture. Overworking will sometimes cause partial breaking of the emulsion before the final spreading is completed; this results in a nonuniform material

that will have poor appearance and low durability. Adjust or delete the wording within the brackets to agree with paragraphs Tack Coat Application and Wetting Pavement Surface.
****

Areas which cannot be reached with the application equipment, or areas with minor defects shall have the sealers applied with hand squeegees or shall be sprayed by the wand to provide complete and uniform coverage. These areas shall be tacked and fogged as required prior to placing sealer by hand.

3.3 CURING

****
NOTE: Emulsified sealer mixtures, depending upon the emulsion characteristics in relation to the aggregate used, may cure primarily by evaporation of water from the surface, by deposition of binder on the aggregate to free the water, or by a combination of both. If curing is from the surface downward, the surface may present a cured appearance but the material below may be uncured. Before traffic is permitted, a thorough cure must be ensured. Manufacturer's recommendations should be followed in setting cure times. Normally 24 hours or overnight is sufficient for the initial cure. Generally, the thicker the coating applied, the longer the cure period.
****

Sealed pavement shall be protected from traffic by barricades and markers until the seal has cured a minimum of [_____] hours. Areas which are damaged by traffic or from other causes shall be repaired by the Contractor at no cost to the Government.

3.4 RETEST AND REJECTION

If the results of any test do not conform to the requirements of this specification, the sealer will be rejected. Retesting of nonconforming materials or new materials shall be at the Contractor's expense and at the Contracting Officer's discretion.

3.5 CLEANUP

On completion of work, all trash, discarded seal material, or other refuse shall be collected and removed from the site and disposed of as approved by the Contracting Officer.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02763 (September 1998)**
U.S. ARMY CORPS OF ENGINEERS **---------------------------**
Superseding
CEGS-02580 (February 1991)

GUIDE SPECIFICATION FOR CONSTRUCTION

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DEPARTMENT OF THE ARMY **CEGS-02763 (September 1998)**
U.S. ARMY CORPS OF ENGINEERS **---------------------------**
Superseding
CEGS-02580 (February 1991)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 02763

PAVEMENT MARKINGS
09/98

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NOTE: This guide specification covers the requirements for marking and remarking airport and heliport pavements primarily, but may also be used for marking roads, streets and parking areas; this section also includes removal of paint or tape markings from pavement surfaces. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for preformed tape and thermosetting plastic compounds. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.
****

PART 1 GENERAL

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NOTE: Pavement markings are usually removed by water blasting; few chemical methods are effective. Sand or shotblasting may be prohibited by local air pollution regulations. Drawings will show the

extent of pavement to have markings removed.

Removal of raised or recessed markers or reflectors is not covered in this section.

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1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 247	(1981) Glass Beads Used in Traffic Paint

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 792	(1991) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D 4280	(1996) Extended Life Type, Nonplowable, Prismatic, Raised, Retroreflective Pavement Markers
ASTM D 4505	(1996) Preformed Plastic Pavement Marking Tape for Extended Service Life
ASTM E 28	(1997) Softening Point of Resins by Ring and Ball Apparatus

FEDERAL SPECIFICATIONS (FS)

FS TT-B-1325	(Rev C; Notice 1) Beads (Glass Spheres) Retro-Reflective (Metric)
FS TT-P-1952	(Rev D) Paint, Traffic and Airfield Marking, Waterborne (Metric)

1.2 UNIT PRICES

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NOTE: This paragraph should be deleted when pavement marking is included in a lump sum project.

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1.2.1 Measurement

1.2.1.1 Surface Preparation

The unit of measurement for surface preparation will be the number of square feet of pavement surface prepared for marking and accepted by the Contracting Officer.

1.2.1.2 Pavement Striping and Markings

The unit of measurement for pavement striping and markings will be the number of square feet of reflective and nonreflective striping or marking actually completed and accepted by the Contracting Officer.

1.2.1.3 Raised Pavement Markers

The unit of measurement for raised pavement markers will be the number of square feet of each specific color required. Payment will be for the total number actually placed and approved by the Contracting Officer.

1.2.1.4 Removal of Pavement Markings

The unit of measurement for removal of pavement markings shall be the number of square feet of pavement markings actually removed and accepted by the Contracting Officer.

1.2.2 Payment

The quantities of surface preparation, pavement striping or markings, raised pavement markers, and removal of pavement markings determined as specified in paragraph Measurement, will be paid for at the contract unit price. The payment will constitute full compensation for furnishing all labor, materials, tools, equipment, appliances, and doing all work involved in marking pavements. Any striping or markings which are placed without reflective media, when reflective media is required, shall be removed and replaced at no cost to the Government. Striping or markings which do not conform to the alignment and/or location required shall be removed and replaced at no cost to the Government.

1.3 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

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Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment Lists; GA.

Lists of proposed equipment, including descriptive data, and notifications of proposed Contractor actions as specified in this section. List of removal equipment shall include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation.

SD-06 Instructions

Mixing, Thinning and Application; [_____].

Manufacturer's current printed product description and Material Safety Data Sheets (MSDS) for each type paint/color proposed for use.

SD-08 Statements

Qualifications; [_____].

Document certifying that personnel are qualified for equipment operation and handling of chemicals.

SD-09 Reports

Material Tests; [_____].

Certified copies of the test reports, prior to the use of the materials at the jobsite. Testing shall be performed in an approved independent laboratory.

SD-13 Certificates

Volatile Organic Compound (VOC) Content; [_____].

Certificate stating that the proposed pavement marking paint meets the VOC regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located.

1.4 DELIVERY AND STORAGE

All materials shall be delivered and stored in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, and directions, all of which shall be plainly legible at time of use.

1.5 EQUIPMENT

All machines, tools and equipment used in the performance of the work shall be approved and maintained in satisfactory operating condition. Equipment operating on roads and runways shall display low speed traffic markings and traffic warning lights.

1.5.1 Paint Application Equipment

The equipment to apply paint to pavements shall be a self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. The machine shall have a speed during application not less than 5 mph, and shall be capable of applying the stripe widths indicated, at the paint coverage rate specified in paragraph APPLICATION, and of even uniform thickness with clear-cut edges. [Equipment used for marking streets and highways shall be capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines or a combination of solid and intermittent lines using a maximum of two different colors of paint as specified.] [The equipment used to apply the paint binder to airfield pavements shall be a self-propelled or mobile-drawn pneumatic spraying machine with an arrangement of atomizing nozzles capable of applying a line width at any one time in multiples of 6 inches, from 6 inches to 36 inches]. The paint applicator shall have paint reservoirs or tanks of sufficient capacity and suitable gauges to apply paint in accordance with requirements specified. Tanks shall be equipped with suitable air-driven mechanical agitators. The spray mechanism shall be equipped with quick-action valves conveniently located, and shall include necessary pressure regulators and gauges in full view and reach of the operator. Paint strainers shall be installed in paint supply lines to ensure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator shall be readily adaptable for attachment of an air-actuated dispenser for the reflective media approved for use. Pneumatic spray guns shall be provided for hand application of paint in areas where the mobile paint applicator cannot be used.

1.5.2 Thermoplastic Application Equipment

1.5.2.1 Thermoplastic Material

Thermoplastic material shall be applied to the primed pavement surface by spray techniques or by the extrusion method, wherein one side of the shaping die is the pavement and the other three sides are contained by, or are part of, suitable equipment for heating and controlling the flow of material. By either method, the markings shall be applied with equipment that is capable of providing continuous uniformity in the dimensions of the stripe.

1.5.2.2 Application Equipment

a. Application equipment shall provide continuous mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the extrusion shoe or spray gun shall prevent accumulation and clogging. All parts of the equipment which come into contact with the material shall be easily accessible and exposable for cleaning and maintenance. All mixing and conveying parts up to and including the extrusion shoes and spray guns shall maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.

b. The application equipment shall be constructed to ensure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off stripe ends squarely and shall provide a method of applying "skiplines". The equipment shall be capable of applying varying widths of traffic markings.

c. The applicator shall be equipped with a drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at controlled rates of flow. The bead dispenser shall be automatically operated and shall begin flow prior to the flow of composition to assure that the strip is fully reflectorized.

1.5.2.3 Mobile and Maneuverable

Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. The equipment used for the placement of thermoplastic pavement markings shall be of two general types: mobile applicator and portable applicator.

a. Mobile Application Equipment: The mobile applicator shall be defined as a truck-mounted, self-contained pavement marking machine that is capable of hot applying thermoplastic by either the extrusion or spray method. The unit shall be equipped to apply the thermoplastic marking material at temperatures exceeding 375 degrees F, at widths varying from 3 to 12 inches and in thicknesses varying from 0.020 to 0.190 inch and shall have an automatic drop-on bead system. The mobile unit shall be capable of operating continuously and of installing a minimum of 20,000 lineal feet of longitudinal markings in an 8-hour day.

(1) The mobile unit shall be equipped with a melting kettle which holds a minimum of 6000 pounds of molten thermoplastic material. The kettle shall be capable of heating the thermoplastic composition to temperatures of 375 to 425 degrees F. A thermostatically controlled heat transfer liquid shall be used. Heating of the composition by direct flame will not be allowed. Oil and material temperature gauges shall be visible at both ends of the kettle. [The mobile unit shall be equipped with a minimum of two extrusion shoes located one on each side of the truck, and shall be capable of marking simultaneous edgeline and centerline stripes. Each extrusion shoe shall be a closed, oil-jacketed unit; shall hold the molten thermoplastic at a temperature of 375 to 425 degrees F; and shall be capable of extruding a line of 3 to 8 inches in width; and at a thickness of not less than 0.125 inch nor more than 0.190 inch, and of generally uniform cross section.] [The mobile unit shall be equipped with a spray gun system. The spray system shall consist of a minimum of four spray guns, located two on each side of the truck, and shall be capable of marking simultaneous edgeline and centerline stripes. The spray system shall be surrounded (jacketed) with heating oil to maintain the molten thermoplastic at a temperature of 375 to 425 degrees F; and shall be capable of spraying a stripe of 3 to 12 inches in width, and in thicknesses varying from 0.055 inch to 0.095 inch, and of generally uniform cross section.]

(2) The mobile unit shall be equipped with an electronic programmable line pattern control system. The control system shall be capable of applying skip or solid lines in any sequence, through any and all of the extrusion shoes, or the spray guns, and in programmable cycle lengths. In addition, the mobile unit shall be equipped with an automatic counting mechanism capable of recording the number of lineal feet of thermoplastic markings applied to the pavement surface with an accuracy of 0.5 percent.

b. Portable Application Equipment: The portable applicator shall be defined as hand-operated equipment, specifically designed for placing special markings such as crosswalks, stopbars, legends, arrows, and short lengths of lane, edge and centerlines. The portable applicator shall be capable of applying thermoplastic pavement markings by the extrusion method. The portable applicator shall be loaded with hot thermoplastic composition from the melting kettles on the mobile applicator. The portable applicator shall be equipped with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories, so as to be capable of holding the molten thermoplastic at a temperature of 375 to 425 degrees F, of extruding a line of 3 to 12 inches in width, and in thicknesses of not less than 0.125 inch nor more than 0.190 inch and of generally uniform cross section.

1.5.3 Reflective Media Dispenser

The dispenser for applying the reflective media shall be attached to the paint dispenser and shall operate automatically and simultaneously with the applicator through the same control mechanism. The dispenser shall be capable of adjustment and designed to provide uniform flow of reflective media over the full length and width of the stripe at the rate of coverage specified in paragraph APPLICATION, at all operating speeds of the applicator to which it is attached.

1.5.4 Preformed Tape Application Equipment

Mechanical application equipment shall be used for the placement of preformed marking tape. Mechanical application equipment shall be defined as a mobile pavement marking machine specifically designed for use in applying precoated, pressure-sensitive pavement marking tape of varying widths, up to 12 inches. The applicator shall be equipped with rollers, or other suitable compactive device, to provide initial adhesion of the preformed, pressure-sensitive marking tape with the pavement surface. Additional hand-operated rollers shall be used as required to properly seat the thermoplastic tape.

1.5.5 Surface Preparation Equipment

1.5.5.1 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 cfm of air at a pressure of not less than 90 psi at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

1.5.5.2 Waterblast Equipment

The water pressure shall be specified at 2600 psi at 140 degrees F in order to adequately clean the surfaces to be marked.

1.5.6 Marking Removal Equipment

Equipment shall be mounted on rubber tires and shall be capable of removing markings from the pavement without damaging the pavement surface or joint sealant. Waterblasting equipment shall be capable of producing an adjustable, pressurized stream of water. Sandblasting equipment shall include an air compressor, hoses, and nozzles. The compressor shall be equipped with traps to maintain the air free of oil and water.

1.5.6.1 Shotblasting Equipment

Shotblasting equipment shall be capable of producing an adjustable depth of removal of marking and pavement. Each unit shall be self-cleaning and self-contained, shall be able to confine dust and debris from the operation, and shall be capable of recycling the abrasive for reuse.

1.5.6.2 Chemical Equipment

Chemical equipment shall be capable of application and removal of chemicals from the pavement surface, and shall leave only non-toxic biodegradeable residue.

1.5.7 Traffic Controls

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NOTE: Guidance for traffic control procedures can be obtained from the Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways.
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Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Small markers shall be placed along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Painting equipment shall be marked with large warning signs indicating slow-moving painting equipment in operation.

1.6 HAND-OPERATED, PUSH-TYPE MACHINES

****
NOTE: Where pavement marking is limited to small street and parking areas, hand-operated push-type machines may be specified in lieu of detailed equipment requirements.
****

All machines, tools, and equipment used in performance of the work shall be approved and maintained in satisfactory operating condition. Hand-operated push-type machines of a type commonly used for application of paint to pavement surfaces will be acceptable for marking small streets and parking areas. Applicator machine shall be equipped with the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Sandblasting equipment shall be provided as required for cleaning surfaces to be painted. Hand-operated spray guns shall be provided for use in areas where push-type machines cannot be used.

1.7 MAINTENANCE OF TRAFFIC

1.7.1 Airfield

The performance of work in the controlled zones of airfields shall be coordinated with the Contracting Officer and with the Flight Operations Officer. Verbal communications shall be maintained with the control tower before and during work in the controlled zones of the airfield. The control tower shall be advised when the work is completed. A radio for this purpose [will be provided by the Government] [shall be provided by the Contractor and approved by the Contracting Officer].

1.7.2 Roads, Streets, and Parking Areas

When traffic must be rerouted or controlled to accomplish the work, the necessary warning signs, flagpersons, and related equipment for the safe passage of vehicles shall be provided.

1.8 WEATHER LIMITATIONS FOR REMOVAL

Pavement surface shall be free of snow, ice, or slush. Surface temperature shall be at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting. Operation shall cease during thunderstorms. Operation shall cease during rainfall, except for waterblasting and removal of previously applied chemicals. Waterblasting shall cease where surface water accumulation alters the effectiveness of material removal.

PART 2 PRODUCTS

2.1 PAINT

The paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of 6 months. Paints for airfields, roads, and streets shall conform to FS TT-P-1952, color as [indicated] [selected]. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.

2.2 THERMOPLASTIC COMPOUNDS

The thermoplastic reflectorized pavement marking compound shall be extruded or sprayed in a molten state onto a primed pavement surface. Following a surface application of glass beads and upon cooling to normal pavement temperatures, the marking shall be an adherent reflectorized strip of the specified thickness and width that is capable of resisting deformation by traffic.

2.2.1 Composition Requirements

The binder component shall be formulated as a hydrocarbon resin. The pigment, beads and filler shall be uniformly dispersed in the binder resin. The thermoplastic composition shall be free from all skins, dirt, and foreign objects and shall comply with the following requirements:

	Percent by Weight	
Component	White	Yellow
Binder	17 min.	17 min.
Titanium dioxide	10 min.	-
Glass beads,	20 min.	20 min.
Calcium carbonate & inert fillers	49 max.	*
Yellow pigments	-	*

*Amount and type of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, providing the other composition requirements of this specification are met.

2.2.2 Physical Properties

2.2.2.1 Color

The color shall be as indicated.

2.2.2.2 Drying Time

When installed at 70 degrees F and in thicknesses between 1/8 and 3/16 inch, the composition shall be completely solid and shall show no damaging effect from traffic after curing 15 minutes.

2.2.2.3 Softening Point

The composition shall have a softening point of not less than 194 degrees F when tested in accordance with ASTM E 28.

2.2.2.4 Specific Gravity

The specific gravity of the composition shall be between 1.9 and 2.2 as determined in accordance with ASTM D 792.

2.2.3 Asphalt Concrete Primer

The primer for asphalt concrete pavements shall be a thermosetting adhesive with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved and/or dispersed in a volatile organic solvent. The solids content shall not be less than 10 percent by weight at 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.005 inch plus or minus 0.001 inch, shall dry to a tack-free condition in less than 5 minutes.

2.2.4 Portland Cement Concrete Primer

The primer for Portland cement concrete pavements shall be an epoxy resin primer. The primer shall be of the type recommended by the manufacturer of the thermoplastic composition. Epoxy primers recommended by the manufacturer shall be approved by the Contracting Officer prior to use. Requests for approval shall be accompanied with technical data, instructions for use, and a 1 quart sample of the primer material.

2.3 PREFORMED TAPE

The preformed tape shall be an adherent reflectorized strip in accordance with ASTM D 4505 Type I or IV, Class optional.

2.4 RAISED REFLECTIVE MARKERS

****

NOTE: Line marker segments having a 1 to 3 ratio of stripe to gap are standard. Line segments of 3 meters (10 feet) with gaps of 9 meters (30 feet) are recommended. When raised pavement markers are used in lieu of striping, the line marker segments shall have a 3 to 5 ratio of stripe to gap with line segments of 5 meters (15 feet) with gaps of 8 meters (25 feet) recommended.

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Either metallic or nonmetallic markers of the button or prismatic reflector type may be used. Markers shall be of permanent colors, as specified for pavement marking, and shall retain the color and brightness under the action of traffic. Button markers shall have a diameter of not less than 4 inches, and shall be spaced not more than 40 feet apart on solid longitudinal lines. Broken centerline marker spacings shall be in segments [of [_____]] [indicated] with gaps [of [_____]] [indicated] between segments. Markers shall have rounded surfaces presenting a smooth contour to traffic and shall not project more than 3/4 inch above level of pavement. Pavement markers and adhesive epoxy shall conform to ASTM D 4280.

2.5 REFLECTIVE MEDIA

Reflective media for airfields shall conform to FS TT-B-1325, Type I, Gradation A. Reflective media for roads and streets shall conform to FS TT-B-1325, Type I, Gradation A or AASHTO M 247, Type I.

2.6 SAMPLING AND TESTING

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NOTE: Although provision is made for obtaining test reports, importance of Government testing of each batch of paint and reflective media is emphasized where quantities of 200 or more liters (50 or more gallons) are involved. For 200 (50) or less, the factor of time and value of material versus cost of testing may justify acceptance on the basis of test reports furnished. In such cases acceptability will be determined by persons within division or district offices technically qualified and specifically designated by division engineers. Requirements in this paragraph for Contractor testing may be modified to exempt materials that definitely will be Government tested. If all batches will be Government tested, requirements for Contractor testing will be deleted.

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Materials proposed for use shall be stored on the project site in sealed and labeled containers, or segregated at source of supply, sufficiently in advance of needs to allow 60 days for testing. Upon notification by the Contractor that the material is at the site or source of supply, a sample shall be taken by random selection from sealed containers by the Contractor in the presence of a representative of the Contracting Officer. Samples shall be clearly identified by designated name, specification number, batch number, manufacturer's formulation number, project contract number, intended use, and quantity involved. [Materials will be sampled and tested by the Government. No material shall be used at the project prior to receipt by the Contractor of written notice that the materials meet the laboratory requirements. The cost of initial testing of samples from each lot of materials will be borne by the Government. If the sample fails to meet specification requirements, the material represented by the sample shall be replaced and the new material will be tested. Cost of sampling and testing the new material will be borne by the Contractor.] [Testing shall be performed in an approved independent laboratory. If materials are approved based on reports furnished by the Contractor, samples will be retained by the Government for possible future testing should the material appear defective during or after application.]

PART 3   EXECUTION

3.1   SURFACE PREPARATION

****

NOTE: Newly laid flexible and rigid pavements require aging prior to painting in order to obtain satisfactory paint performance. If practicable, all new pavement surfaces should be at least 30 days old before applying paint. When earlier application of paint is necessary because of operations requirements, the maximum period practicable should be specified.

****

Surfaces to be marked shall be thoroughly cleaned before application of the pavement marking material. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required. Rubber deposits, surface laitance, existing paint markings, and other coatings adhering to the pavement shall be completely removed with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion as directed. Areas of old pavement affected with oil or grease shall be scrubbed with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinsed thoroughly after each application. After cleaning, oil-soaked areas shall be sealed with cut shellac to prevent bleeding through the new paint. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping or marking. Surfaces shall be recleaned, when work has been stopped due to rain.

3.1.1   Pretreatment for Early Painting

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NOTE: For new rigid pavements which require early painting, the following paragraph will be added.

****

Where early painting is required on rigid pavements, a pretreatment with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride shall be applied to prepared pavement areas prior to painting.

3.1.2   Cleaning Existing Pavement Markings

In general, markings shall not be placed over existing pavement marking patterns. Existing pavement markings, which are in good condition but interfere or conflict with the newly applied marking patterns, shall be removed. Deteriorated or obscured markings that are not misleading or confusing or interfere with the adhesion of the new marking material do not require removal. New preformed and thermoplastic pavement markings shall not be applied over existing preformed or thermoplastic markings. Whenever grinding, scraping, sandblasting or other operations are performed the work must be conducted in such a manner that the finished pavement surface is not damaged or left in a pattern that is misleading or confusing. When these operations are completed the pavement surface shall be blown off with compressed air to remove residue and debris resulting from the cleaning work.

3.1.3   Cleaning Concrete Curing Compounds

On new Portland cement concrete pavements, cleaning operations shall not begin until a minimum of 30 days after the placement of concrete. All new concrete pavements shall be cleaned by either sandblasting or water blasting. When water blasting is performed, thermoplastic and preformed markings shall be applied no sooner than 24 hours after the blasting has been completed. The extent of the blasting work shall be to clean and prepare the concrete surface as follows:

a. There is no visible evidence of curing compound on the peaks of the textured concrete surface.

b. There are no heavy puddled deposits of curing compound in the valleys of the textured concrete surface.

c. All remaining curing compound is intact; all loose and flaking material is removed.

d. The peaks of the textured pavement surface are rounded in profile and free of sharp edges and irregularities.

e. The surface to be marked is dry.

3.2 APPLICATION

All pavement markings and patterns shall be placed as shown on the plans.

3.2.1 Paint

Paint shall be applied to clean, dry surfaces, and only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Paint temperature shall be maintained within these same limits. New asphalt pavement surfaces and new Portland concrete cement shall be allowed to cure for a period of not less than 30 days before applications of paint. Paint shall be applied pneumatically with approved equipment at rate of coverage specified . The Contractor shall provide guide lines and templates as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.

3.2.1.1 Rate of Application

a. Reflective Markings: Pigmented binder shall be applied evenly to the pavement area to be coated at a rate of 105 plus or minus 5 square feet per gallon. Glass spheres shall be applied uniformly to the wet paint [on airfield pavement at a rate of 8] [on road and street pavement at a rate of 6] plus or minus 0.5 pounds of glass spheres per gallon of paint.

b. Nonreflective Markings: Paint shall be applied evenly to the pavement surface to be coated at a rate of 105 plus or minus 5 square feet per gallon.

3.2.1.2 Drying

The maximum drying time requirements of the paint specifications will be strictly enforced to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a delay in drying of the markings, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

3.2.2   Thermoplastic Compounds

Thermoplastic pavement markings shall be placed upon dry pavement; surface dry only will not be considered an acceptable condition. At the time of installation, the pavement surface temperature shall be a minimum of 40 degrees F and rising. Thermoplastics, as placed, shall be free from dirt or tint.

3.2.2.1   Longitudinal Markings

All centerline, skipline, edgeline, and other longitudinal type markings shall be applied with a mobile applicator. All special markings, crosswalks, stop bars, legends, arrows, and similar patterns shall be placed with a portable applicator, using the extrusion method.

3.2.2.2   Primer

After surface preparation has been completed the asphalt and/or concrete pavement surface shall be primed. The primer shall be applied with spray equipment. Primer materials shall be allowed to "set-up" prior to applying the thermoplastic composition. The asphalt concrete primer shall be allowed to dry to a tack-free condition, usually occurring in less than 10 minutes. The Portland cement concrete primer shall be allowed to dry in accordance with the thermoplastic manufacturer's recommendations. To shorten the curing time of the epoxy resins an infrared heating device may be used on the concrete primer.

a. Asphalt Concrete Primer: Primer shall be applied to all asphalt concrete pavements at a wet film thickness of 0.005 inch, plus or minus 0.001 inch (265-400 square feet per gallon).

b. Portland Cement Concrete Primer: Primer shall be applied to all concrete pavements (including concrete bridge decks) at a wet film thickness of between 0.04 to 0.05 inch (320-400 square feet per gallon).

3.2.2.3   Markings

After the primer has "set-up", the thermoplastic shall be applied at temperatures no lower than 375 degrees F nor higher than 425 degrees F at the point of deposition. Immediately after installation of the marking, drop-on glass spheres shall be mechanically applied so that the spheres are held by and imbedded in the surface of the molten material.

a. Extruded Markings: All extruded thermoplastic markings shall be applied at the specified width and at a thickness of not less than 0.125 inch nor more than 0.190 inch.

b. Sprayed Markings: All sprayed thermoplastic markings shall be applied at the specified width and the thicknesses designated in the contract plans. If the plans do not specify a thickness, centerline markings shall be applied at a wet thickness of 0.090 inch, plus or minus 0.005 inch, and edgeline markings at a wet thickness of 0.060 inch, plus or minus 0.005 inch.

c. Reflective Glass Spheres: Immediately following application, reflective glass spheres shall be dropped onto the molten thermoplastic marking at the rate of 1 pound per 20 square feet of compound.

3.2.3 Preformed Tape

The pavement surface temperature shall be a minimum of 60 degrees F and the ambient temperature shall be a minimum of 60 degrees F and rising. The preformed markings shall be placed in accordance with the manufacturer's written instructions.

3.2.4 Raised Reflective Markers

Prefabricated markers shall be aligned carefully at the required spacing and permanently fixed in place by means of epoxy resin adhesives. To insure good bond, pavement in areas where markers will be set shall be thoroughly cleaned by sandblasting and use of compressed air prior to applying adhesive.

3.2.5 Reflective Media

Application of reflective media shall immediately follow application of pigmented binder. Drop-on application of glass spheres shall be accomplished to insure that reflective media is evenly distributed at the specified rate of coverage. Should there be malfunction of either paint applicator or reflective media dispenser, operations shall be discontinued immediately until deficiency is corrected.

3.3 MARKING REMOVAL

Pavement marking, including plastic tape, shall be removed in the areas shown on the drawings. Removal of marking shall be as complete as possible without damage to the surface. Aggregate shall not be exposed by the removal process. After the markings are removed, the cleaned pavement surfaces shall exhibit adequate texture for remarking as specified in paragraph SURFACE PREPARATION. Contractor shall demonstrate removal of pavement marking in an area designated by the Contracting Officer. The demonstration area will become the standard for the remainder of the work.

3.3.1 Equipment Operation

Equipment shall be controlled and operated to remove markings from the pavement surface, prevent dilution or removal of binder from underlying pavement, and prevent emission of blue smoke from asphalt or tar surfaces.

3.3.2 Cleanup and Waste Disposal

The worksite shall be kept clean of debris and waste from the removal operations. Cleanup shall immediately follow removal operations in areas subject to air traffic. Debris shall be disposed of at approved sites.

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-02770 (March 1998)**
U.S. ARMY CORPS OF ENGINEERS | **-----------------------**
Superseding
CEGS-02511 (January 1989)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 1 (April 1999)

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SECTION 02770

CONCRETE SIDEWALKS AND CURBS AND GUTTERS
03/98

****

NOTE: This guide specification covers the requirements for concrete sidewalks and curbs and gutters. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for sidewalks, and curbs and gutters. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****

NOTE: The specification may be adjusted to cover separate curbs and gutters or combination curbs and gutters. This guide specification will not be used for integral or monolithic curbs of concrete

pavement or for curbs and gutters for bridges.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(1991) Burlap Cloth Made from Jute or Kenaf

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185	(1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 615/A 615M	(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616/A 616M	(1996a) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617/A 617M	(1996a) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM C 31/C 31M	(1996) Making and Curing Concrete Test Specimens in the Field
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 171	(1997) Sheet Materials for Curing Concrete
ASTM C 172	(1997) Sampling Freshly Mixed Concrete
ASTM C 173	(1996) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 309	(1997) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 920	(1995) Elastomeric Joint Sealants
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient

	Bituminous Types)
ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 3405	(1996) Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements

1.2 MEASUREMENT FOR PAYMENT

****
NOTE: The MEASUREMENT FOR PAYMENT and BASIS FOR PAYMENT paragraphs will be deleted if the work covered by this section of the specifications is included in one lump-sum contract price for the entire work covered by the invitation for bids.
****

1.2.1 Sidewalks

The quantities of sidewalks to be paid for will be the number of square yards of each depth of sidewalk constructed as indicated.

1.2.2 Curbs and Gutters

The quantities of curbs and gutters to be paid for will be the number of linear feet of each cross section constructed as indicated, measured along the face of the curb at the gutter line.

1.3 BASIS FOR PAYMENT

1.3.1 Sidewalks

Payment of the quantities of sidewalks measured as specified will be at the contract unit price per square yard of the thickness specified.

1.3.2 Curbs and Gutters

Payment of the quantities of curbs and gutters measured as specified will be at the contract unit price per linear foot of each cross section.

1.4 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-09 Reports

Field Quality Control; [_____].

Copies of all test reports within 24 hours of completion of the test.

SD-18 Records

Concrete; [_____].

Copies of certified delivery tickets for all concrete used in the construction.

1.5 WEATHER LIMITATIONS

1.5.1 Placing During Cold Weather

Concrete placement shall not take place when the air temperature reaches 40 degrees F and is falling, or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40 degrees F. Provisions shall be made to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection shall be approved in writing. Approval will be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. [Mixing water and aggregates] [Mixing water] [Aggregates] shall be heated as necessary to result in the temperature of the in-place concrete being between 50 and 85 degrees F. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.5.2 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed 85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. The placing temperature shall not exceed 95 degrees F at any time.

1.6 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.6.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The Contracting Officer shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.6.2 Slip Form Equipment

Slip form paver or curb forming machine, will be approved based on trial use on the job and shall be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in 1 pass.

PART 2 PRODUCTS

2.1 CONCRETE

Concrete shall conform to the applicable requirements of [Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE] [Section 02753 CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER HEAVY-DUTY PAVEMENTS] [Section 02754 CONCRETE PAVEMENTS FOR SMALL PROJECT] except as otherwise specified. Concrete shall have a minimum compressive strength of 3500 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches.

2.1.1 Air Content

****

NOTE: The air content specified is for concrete that will be subjected to freezing weather and the possible action of deicing chemicals. In climates where freezing is not a factor but where air entrainment is used in local commercial practice to improve the workability and placeability of concrete, concrete having air content percent of 4-1/2 plus or minus 1-1/2 percent may be specified as Contractor's option to non air-entrained concrete.

****

Mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

****

NOTE: The desired slump will be inserted. Suggested limits are 75 mm (3 inches) plus or minus 25 mm (1 inch) for hand placed concrete or 25 mm (1 inch) plus or minus 10 mm (1/2 inch) for slipformed concrete.

****

The concrete slump shall be 2 inches plus or minus 1 inch where determined in accordance with ASTM C 143.

2.1.3 Reinforcement Steel

****

NOTE: Reinforcement steel normally will not be required for curb and gutter construction. Where conditions exist that make it advantageous to use

reinforcement steel, the reinforcing steel details will be indicated, and the following paragraphs will be included in the contract specification.
****

Reinforcement bars shall conform to ASTM A 615/A 615M, ASTM A 616/A 616M, or ASTM A 617/A 617M. Wire mesh reinforcement shall conform to ASTM A 185.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.2.2 Burlap

Burlap shall conform to AASHTO M 182.

2.2.3 White Pigmented Membrane-Forming Curing Compound

White pigmented membrane-forming curing compound shall conform to ASTM C 309, Type 2.

2.3 CONCRETE PROTECTION MATERIALS

Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.4 JOINT FILLER STRIPS

2.4.1 Contraction Joint Filler for Curb and Gutter

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

2.4.2 Expansion Joint Filler, Premolded

****
NOTE: Either type of joint sealer may be specified if determined necessary by the Contracting Officer and the inapplicable publication removed. Joint sealing material may be omitted where sealing of expansion joints is not deemed essential or advisable.
****

Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, 3/8 inch thick, unless otherwise indicated.

2.5 JOINT SEALANTS

2.5.1 Joint Sealant, Cold-Applied

Joint sealant, cold-applied shall conform to ASTM C 920.

2.5.2 Joint Sealant, Hot-Poured

Joint sealant, hot-poured shall conform to ASTM D 3405.

2.6 FORM WORK

Form work shall be designed and constructed to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 2 inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 10 feet. Radius bends may be formed with 3/4 inch boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 10 feet with a minimum of 3 welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.6.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

2.6.2 Curb and Gutter Forms

Curb and gutter outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside form. Rigid forms shall be provided for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

****

NOTE: On most projects, major grading operations involving excavation and construction of embankments will be performed and paid for under other sections of the specifications and, therefore, are not included in this guide specification. Where such work, including the construction of any required subbase, must be done under this section, paragraphs FORM SETTING, SIDEWALK CONCRETE PLACEMENT AND FINISHING, and CURB AND GUTTER CONCRETE PLACEMENT

AND FINISHING will be revised to cover necessary additional requirements. The subgrade will be indicated as extending at least 600 mm (2 feet) in width back of curb, gutter, entrance, and combination curb and gutters.
****

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted [as directed] [in conformance with Section [_____]].

3.1.1 Sidewalk Subgrade

The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Curb and Gutter Subgrade

The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement.

3.1.3 Maintenance of Subgrade

The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited.

3.2 FORM SETTING

Forms shall be set to the indicated alignment, grade and dimensions. Forms shall be held rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to ensure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Forms for sidewalks shall be set with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set, grade and alignment shall be checked with a 10 foot straightedge. Forms shall have a transverse slope [as indicated] [of 1/4 inch per foot] with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

3.2.2 Curbs and Gutters

The forms of the front of the curb shall be removed not less than 2 hours nor more than 6 hours after the concrete has been placed. Forms back of curb shall remain in place until the face and top of the curb have been finished, as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Concrete shall be placed in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a strike off.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished with a wood float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished with an edger having a radius of 1/8 inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

3.3.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 5/16 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

3.4.1 Formed Curb and Gutter

Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators. Curve shaped gutters shall be finished with a standard curb "mule".

3.4.2 Curb and Gutter Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

3.4.3 Concrete Finishing

Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces shall then be brushed with a fine-hair brush with longitudinal strokes.

The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 1/2 inch. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The front curb surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float.

3.4.4 Joint Finishing

Curb edges at formed joints shall be finished as indicated.

3.4.5 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 1/4 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.5 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 10 feet or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated.

3.5.1 Sidewalk Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8 inch blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

3.5.2 Sidewalk Expansion Joints

****

NOTE: Expansion-joint filler will not be required between curbs that abut the sidewalk longitudinally. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D 1752 or building paper.

For projects which do not reference Section 02760 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS, the last paragraph will replace the

reference to Section 02760.
****

Expansion joints shall be formed with [3/8] [1/2] [_____] inch joint filler strips. Joint filler shall be placed with top edge 1/4 inch below the surface and shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 1/8 inch, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be cleaned and filled with joint sealant. [Joints shall be sealed as specified in Section 02760 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS.] [The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.]

3.5.3 Reinforcement Steel Placement

****
NOTE: Reinforcement steel normally will not be required for curb and gutter construction. Where conditions exist that make it advantageous to use reinforcement steel, the reinforcing steel details will be indicated, and the following paragraphs will be included in the contract specification.
****

Reinforcement steel shall be accurately and securely fastened in place with suitable supports and ties before the concrete is placed.

3.6 CURB AND GUTTER JOINTS

Curb and gutter joints shall be constructed at right angles to the line of curb and gutter.

3.6.1 Contraction Joints

Contraction joints shall be constructed directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length. Contraction joints shall be constructed by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

3.6.2 Expansion Joints

****
NOTE: Intervals between expansion joints of curb and combination curb and gutters adjacent to flexible pavements will not be less than 10 meters (30 feet) nor greater than 35 meters (120 feet).

For projects which do not reference Section 02760 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS, the last paragraph will replace the reference to Section 02760.
****

Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, expansion joints at least [3/8] [1/2] [_____] inch in width shall be provided at intervals not exceeding [_____] feet. Expansion joints shall be provided in nonreinforced concrete gutter at locations indicated. Expansion joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit. [Joints shall be sealed as specified in Section 02760 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS.] [Expansion joints and the top 1 inch depth of curb and gutter contraction-joints shall be sealed with joint sealant. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.]

3.7 CURING AND PROTECTION

****
NOTE: Only the methods of curing appropriate to local weather conditions and construction practices will be retained, but Contractor's option of at least 2 curing methods will be retained to promote competition in bidding.
****

3.7.1 General Requirements

Concrete shall be protected against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Unhardened concrete shall be protected from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.7.1.1 Mat Method

The entire exposed surface shall be covered with 2 or more layers of burlap. Mats shall overlap each other at least 6 inches.The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.7.1.2 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. The curing medium shall not be less than 18-inches wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

3.7.1.3 Membrane Curing Method

A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet per gallon for the total of both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.7.2 Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

3.7.3 Protection

Completed concrete shall be protected from damage until accepted. The Contractor shall repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

3.7.4 Protective Coating

****

NOTE: Concrete may require protection against the action of urea, sodium chloride, and calcium chloride used for de-icing purposes. Protection against these chemicals is not required for concrete of the specified air content that will be in place for a cumulative time of 6 weeks at a continuous minimum temperature of 5 degrees C (40 degrees F), excluding the curing time. Otherwise, concrete which will be exposed to de-icing chemicals will be given protective coating after the curing period. Concrete which is to receive protective coating should be moist cured to eliminate the need for removing a curing membrane prior to application of the protective coating. ACI Committee Report 515 provides a detailed discussion of protective coating for concrete. The following paragraphs will be inserted if protective coating is required.

****

Protective coating of linseed oil mixture shall be applied to the exposed-to-view concrete surface.

3.7.4.1 Application

Curing and backfilling operation shall be completed prior to applying two coats of protective coating. Concrete shall be surface dry and clean before each application. Coverage shall be by spray application at not more than 50 square yards per gallon for first application and not more than 70 square yards per gallon for second application, except that the number of applications and coverage for each application for commercially prepared mixture shall be in accordance with the manufacturer's instructions. Coated surfaces shall be protected from vehicular and pedestrian traffic until dry.

3.7.4.2 Precautions

Protective coating shall not be heated by direct application of flame or electrical heaters and shall be protected from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Material shall not be applied at ambient or material temperatures lower than 50 degrees F.

3.8 FIELD QUALITY CONTROL

3.8.1 General Requirements

The Contractor shall perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, the Contractor shall take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

3.8.2 Concrete Testing

3.8.2.1 Strength Testing

The Contractor shall provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 250 cubic yards of concrete. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31/C 31M by an approved testing laboratory. Each strength test result shall be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi.

3.8.2.2 Air Content

Air content shall be determined in accordance with ASTM C 173 or ASTM C 231. ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.8.2.3 Slump Test

Two slump tests shall be made on randomly selected batches of each class of concrete for every 250 cubic yards, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.8.3 Thickness Evaluation

The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, the subgrade shall be true to grade prior to concrete placement and the thickness will be determined by measuring each edge of the completed slab.

3.8.4 Surface Evaluation

The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

3.9 SURFACE DEFICIENCIES AND CORRECTIONS

3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 1/4 inch. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Government and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02811 (November 1990)**
U.S. ARMY CORPS OF ENGINEERS **-------------------------**

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 9 (July 1998)
Includes Special Change (Tailoring Options) (July 1998)
Includes Text Adjustment Change (Section 01300 Reference) (June 1997)

Latest Notice change indicated by CHG tags

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11/90

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Latest Notice change indicated by CHG tags

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SECTION 02811

UNDERGROUND SPRINKLER SYSTEMS

11/90

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NOTE: This guide specification covers the requirements for underground sprinkler irrigation systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for copper tubing, red brass pipe, galvanized steel pipe, polyvinyl chloride (PVC) pipe, and polyethylene (PE) plastic pipe. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.
****

PART 1 GENERAL

****
NOTE: Irrigation system requirements depend upon

rainfall factors for the project area, plant selections, the quality of growth desired, and budgetary constraints. The area factors will be determined by a registered landscape professional. Reference is made to TM 5-803-13. While the design of a system with pop-up heads may be justified in some geographic areas, bubbler type systems may be required in areas where water conservation methods are being practiced. If source of water supply is from base water main through a service line and water meter, determine amount of water available for irrigation system from static pressure at point of connection to water main. In many cases, water supply is adequate for short durations only. The amount of water required is determined from the type of turf to be irrigated, climate, terrain, and soil conditions. System piping layout, pipe sizes, and selection and spacing of heads and emitters must provide the required amount of water and complete coverage of the irrigated areas. Provide valves to allow irrigation of each area separately.
****

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1997) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM B 32	(1996) Solder Metal
ASTM B 43	(1996) Seamless Red Brass Pipe, Standard Sizes
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM D 1785	(1996a) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(1996a) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2287	(1996) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM D 2464	(1996a) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1996a) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl

	Chloride) (PVC) Plastic Piping Systems
ASTM D 2774	(1994) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3261	(1996) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM F 441	(1995) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.2	(1983; R 1991; Errata May 1992) Gages and Gaging for Unified Inch Screw Threads
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.15	(1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(1995) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE ANSI/ASSE 1012	(1995) Backflow Preventers with Intermediate Atmospheric Vent
ASSE 1013	(1993) Reduced Pressure Principle Backflow Preventers
ASSE 1020	(1974; Rev thru Feb 1989) Pressure Vacuum Breaker Assembly (Recommended for Outdoor Usage)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C509	(1994) Resilient-Seated Gate Valves for Water Supply Service
AWWA C901	(1996) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. Through 3 In., for Water Service

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-51145	(Rev C) Flux, Soldering, Non-Electronic, Paste & Liquid

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR-01	(1993) Manual of Cross-Connection Control

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(1994) Cast Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(1993) Industrial Control and Systems, Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996; Errata 96-4) National Electrical Code

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(1992) Water Hammer Arresters

1.2 PERFORMANCE REQUIREMENTS

****

NOTE: In the design of the sprinkler system reference will be made to TM 5-813-5. For a site where specific pipe or material is required or where certain material will not be acceptable, the requirements will be specified and any restricting locations will be shown on the drawings. The following information will be shown on the drawings:

a. An irrigation legend.

b. The extent, size, type, and location of underground sprinkler irrigation system and all appurtenances including all piping, sprinkler heads, emitters, control valves, and controllers. Indicate obstacles that might interfere with the layout or operation of the system. Indicate where pipe under walks and drives must be bored.

c. All required slopes and elevations.

d. Detail of drain pockets.

e. Flow rates and diameter of coverage for individual sprinkler heads and emitters.

f. Minimum irrigation rates.

g. Size, variety, and assembly of backflow prevention units.

h. Number and extent of electrical or hydraulic controller circuits, if required.

i. Automatic valve schedule and timing, along with valve identification key or legend.

****

System shall operate with a minimum water pressure of [_____] psi at connection to [main] [meter] [building] [backflow prevention device] and [_____] psi at the last head in each zone.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Framed Instructions; [_____].

Labels, signs, and templates of operating instructions that are required to be mounted or installed on or near the product for normal, safe operation.

Field Training ; [_____].

Information describing training to be provided, training aids to be used, samples of training materials to be provided, and schedules and notification of training.

Design Analysis and Calculations; [_____]. Spare Parts; [_____].

Design analyses and pressure calculations verifying that system will provide the irrigation requirements. Spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than the start of the field tests. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-04 Drawings

Sprinkler System; [_____].

Detail drawings for valves, sprinkler heads, backflow preventers, automatic controllers, emitter heads, and water hammer arresters. Drawings shall include a complete list of equipment and materials, and manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Drawings shall also contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will function as a unit. Drawings shall show proposed system layout, type and number of heads and emitters, zone valves, drain pockets, backflow devices, controllers, and mounting details of controllers. As-built Drawings which provide current factual information showing locations of mains, heads, valves, and controllers including deviations from and amendments to the drawings and changes in the work shall be included.

SD-06 Instructions

Sprinkler System; [_____].

Detailed procedures defining the Contractor's provisions for accident prevention, health protection, and other safety precautions for the work to be done.

SD-09 Reports

Field Tests; [_____].

Performance test reports, in booklet form, showing all field tests performed to adjust each component; and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of control valves.

SD-13 Certificates

Sprinkler System; [_____].

The material supplier's or equipment manufacturer's statement that the supplied material or equipment meets specified requirements. Each certificate shall be signed by an official authorized to certify in behalf of material supplier or product manufacturer and shall identify quantity and date or dates of shipment or delivery to which the certificates apply.

SD-19 Operation and Maintenance Manuals

Sprinkler System; [_____].

[Six] [_____] copies of operation and [six] [_____] copies of maintenance manuals for the equipment furnished. One complete set prior to field testing and the remainder upon acceptance. Manuals shall be approved prior to the field training course. Operating manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout, simplified wiring and control diagrams of the system as installed, and system programming schedule.

1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be protected from the weather; excessive humidity and temperature variation; direct sunlight (in the case of plastic or rubber materials); and dirt, dust, or other contaminants.

1.5 FIELD MEASUREMENTS

The Contractor shall verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT REQUIREMENTS

2.1.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer who has produced similar systems which have performed well for a minimum period of 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Each item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.3 Extra Stock

The following extra stock shall be provided: Two sprinkler heads of each size and type, two valve keys for operating manual valves, two wrenches for removing and installing each type of head, two quick coupler keys and hose swivels, and four irrigation controller housing keys.

2.2 PIPING MATERIALS

****

NOTE: Select copper, brass, steel, PVC, or PE piping materials according to project requirements. Verify soil and water conditions onsite, use proper materials where corrosion problems exist.

****

2.2.1   Copper Tubing and Associated Fittings

Tubing shall conform to requirements of ASTM B 88, Type K. Fittings shall conform to ASME B16.22 and ASME B16.18, solder joint. Solder shall conform to ASTM B 32 95-5 tin-antimony. Flux shall conform to CID A-A-51145, Type I.

2.2.2   Red Brass Pipe and Associated Fittings

Pipe shall conform to requirements of ASTM B 43, regular. Fittings shall be Class 250, cast bronze threaded conforming to the requirements of ASME B16.15.

2.2.3   Galvanized Steel Pipe and Associated Fittings

****

NOTE: Use of pipe is limited to fixed shrub head risers and reduced pressure type backflow preventers.

****

Pipe shall conform to requirements of ASTM A 53, Schedule 40. Fittings shall be Class 150 conforming to requirements of ASME B16.3.

2.2.4   Polyvinyl Chloride (PVC) Pipe, Fittings and Solvent Cement

****

NOTE: PVC pipe may be used where frost line is less than 300 mm (12 inches) deep or in areas where piping system can be winterized. Use Schedule 40 PVC fittings with solvent weld; do not use threaded Schedule 40 pipe. For risers use brass pipe or Schedule 80 PVC pipe with Schedule 80 PVC threaded fittings. Locate all risers away from walks. Use solvent cement for unthreaded PVC pipe and fittings. ASTM D 1785, PVC 1120, Schedule 40 is Type I, Grade 1 and wall thickness of Schedule 40. ASTM D 1785, PVC 1120, Schedule 80 is Type I, Grade 2 and wall thickness of Schedule 80. ASTM D 2241, PVC 1120, SDR 21 is Type I, Grade 1 and standard dimension ratio of 21.

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DEPARTMENT OF THE ARMY | **CEGS-02821 (April 1999)**
U.S. ARMY CORPS OF ENGINEERS | **---------------------------**
Superseding
CEGS-02821 (September 1998)

GUIDE SPECIFICATION FOR CONSTRUCTION

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04/99

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U.S. ARMY CORPS OF ENGINEERS **---------------------------**
Superseding
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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02821

FENCING
04/99

****
NOTE: This guide specification covers the requirements for chain link fence for general and high security applications and farm style fence. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for chain link fence, high security fence, and farm style fence. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.
****

PART 1 GENERAL

****
NOTE: This section covers both general and high security applications for chain link fence and will be edited throughout when one of the two

applications is not required.

Standard drawings STD 872-90-02 through 872-90-09 of fence and gate types required will be included as part of the contract drawings; the standard drawings are available at http://www.hnd.usace.army.mil/TECHINFO/index.htm. Layout of fence will be shown including types and locations of gates, and gate sizes. Drawings will also indicate the extent of clearing required.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 116	(1995) Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric
ASTM A 121	(1992a) Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A 153/A 153M	(1998) Zinc-Coated (Hot Dip) on Iron and Steel Hardware
ASTM A 176	(1997) Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A 392	(1996) Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 478	(1997) Chromium-Nickel Stainless and Heat-Resisting Steel Weaving and Knitting Wire
ASTM A 491	(1996) Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A 585	(1997) Aluminum-Coated Steel Barbed Wire
ASTM A 666	(1996b) Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Paste, and Flat Bar
ASTM A 702	(1989; R 1994) Steel Fence Posts and Assemblies, Hot Wrought

ASTM A 780	(1993a) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM A 824	(1995) Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link Fence
ASTM C 94	(1998) Ready-Mixed Concrete
ASTM D 4541	(1995) Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM F 626	(1996) Fence Fittings
ASTM F 668	(1996) Poly(Vinyl Chloride) (PVC)-Coated Steel Chain-Link Fence Fabric
ASTM F 883	(1997) Padlocks
ASTM F 900	(1994) Industrial and Commercial Swing Gates
ASTM F 1043	(1998a) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(1997) Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F 1184	(1994) Industrial and Commercial Horizontal Slide Gates
ASTM G 23	(1996) Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM G 26	(1996) Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM G 53	(1996) Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials

AMERICAN WOOD PRESERVERS ASSOCIATION (AWPA)

AWPA C1	(1997) All Timber products - Preservative Treatment by Pressure Processes
AWPA C4	(1995) Poles - Preservative Treatment by Pressure Processes

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item

should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-13 Certificates

Chain Link Fence; [_____].

Statement, signed by an official authorized to certify on behalf of the manufacturer, attesting that the chain link fence and component materials meet the specified requirements.

SD-19 Operation and Maintenance Manuals

Electro-Mechanical Locks; [_____]. Gate Operator; [_____].

[Six] [_____] copies of operating and maintenance instructions, a minimum of 2 weeks prior to field training. Operating instructions shall outline the step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance instructions shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The instructions shall include the general gate layout, equipment layout and simplified wiring and control diagrams of the system as installed.

PART 2 PRODUCTS

2.1 FENCE FABRIC

Fence fabric shall conform to the following:

2.1.1 Chain Link Fence Fabric

****

NOTE: In salt-laden or corrosive industrial atmosphere, either Class 2 fabric with 610 grams (2.0 ounces) of zinc coating per square meter (foot) or Type I, aluminum-coated fabric, will be specified. In other areas, Class 1 with 370 grams (1.2 ounces) of zinc coating per square meter (foot) or Type I will be specified. Class 2b polyvinyl chloride-coated steel fabric may be specified for other than security purposes when esthetics is of prime importance and the additional cost is justified. Fabric height will be shown on the contract drawings. Fabric height shall be 1.83 m (6

feet) for controlled areas and 2.13 m (7 feet) for restricted areas.
****

[ASTM A 392, [Class 1] [Class 2], zinc-coated steel wire with minimum coating weight of [1.2] [2.0] ounces of zinc per square foot of coated surface, or ASTM A 491, Type I, aluminum-coated steel wire.] [Class 2b polyvinyl chloride-coated steel fabric with 0.3 ounces of zinc coating per square foot in accordance with ASTM F 668.] Fabric shall be fabricated of 9 gauge wire woven in 2 inch mesh. Fabric height shall be [[6] [7] feet] [[_____] feet] [as shown]. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

2.1.2 Woven Wire and Wire Netting

Woven wire shall conform to ASTM A 116 [No. 9 farm] [No. 12-1/2 close mesh] [No. 14-1/2 wolf-proof] [No. 13 poultry and garden] [No. 14-1/2 chick] fence; size as indicated. Wire netting shall conform to ASTM A 116 [light] [heavy] grade; size as indicated.

2.2 GATES

****
NOTE: Type of gates will be shown on the drawings, including degree of swing required. In heavy use conditions overhead slide gates should be considered if clearances permit, because these gates require less maintenance and repair than cantilever gates. Ground level track and roller systems should be avoided in climates where snow and ice may accumulate. Recessed tracks should never be used in climates where the recess may fill with ice and snow. Where gates are to receive electric locks, the gate post foundations should be lowered to frost depth to help prevent misalignment of the lock components.
****

ASTM F 900 and/or ASTM F 1184. Gate shall be the type and swing shown. Gate frames shall conform to strength and coating requirements of ASTM F 1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size (NPS) 1-1/2. Gate frames shall conform to strength and coating requirements of ASTM F 1043, for Group IC, steel pipe with external coating Type A or Type B, nominal pipe size (NPS) 1-1/2. Gate fabric shall be as specified for chain link fabric. Gate leaves more than 8 feet wide shall have either intermediate members and diagonal truss rods or shall have tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 8 feet wide shall have truss rods or intermediate braces. Intermediate braces shall be provided on all gate frames with an electro-mechanical lock. Gate fabric shall be attached to the gate frame by method standard with the manufacturer except that welding will not be permitted. Latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for the operation of the gate. Latches shall be arranged for padlocking so that the padlock will be accessible from both sides of the gate. Stops shall be provided for holding the gates in the open position. For high security applications, each end member of gate frames shall be extended sufficiently above the top member to carry three strands of barbed wire in horizontal alignment with barbed wire strands on the fence.

2.3 POSTS

2.3.1 Metal Posts for Chain Link Fence

****

NOTE: For high security fences that are to be sensored, posts will be limited to Group IA or Group IC steel pipe only.

****

ASTM F 1083, zinc-coated. Group IA, with external coating Type A steel pipe. Group IC steel pipe, zinc-coated with external coating Type A or Type B and Group II , formed steel sections, shall meet the strength and coating requirements of ASTM F 1043. Group III, ASTM F 1043 steel H-section may be used for line posts in lieu of line post shapes specified for the other classes. Sizes shall be as shown on the drawings. Line posts and terminal (corner, gate, and pull) posts selected shall be of the same designation throughout the fence. Gate post shall be for the gate type specified subject to the limitation specified in ASTM F 900 and/or ASTM F 1184.

2.3.2 Metal Posts for Farm Style Fence

Metal posts shall conform to ASTM A 702 zinc-coated, [T-section] [U-Section]; length as indicated. Accessories shall conform to ASTM A 702.

2.3.3 Composite Polyester Resin Reinforced Line Posts

****

NOTE: Composite posts are not allowed for high security fences. Except for high security applications, composite posts may be used as an alternative to PVC coated steel line posts in salt-laden or corrosive industrial atmospheres. Since composite posts are non-conductive, fence grounding procedures need to be detailed where grounding of the fence is required.

****

Polyester resin reinforced line posts shall be produced from unsaturated polyester resin reinforced with E-glass. Posts shall be filled with an appropriate filler material to form a rigid structural support member. The post shall meet the strength requirements of ASTM F 1043 for heavy industrial fencing. Posts shall be protected from UV and moisture degradation by a protective veil impregnated with resin (8 to 12 mil minimum) and an acrylic based (2 mil minimum) coating system. Posts shall exhibit corrosion and ultraviolet resistance as demonstrated when exposed to accelerated environmental test chamber for not less than 3,600 hours. The post shall show no structural failure (i.e., less than 10% loss of strength) as a result of exposure to moisture and lamps required in ASTM G 23, ASTM G 26 and ASTM G 53. Post coating system strength shall be tested in accordance with ASTM D 4541 for 90% adhesion strength. Posts shall be [green] [black] [brown] in color. Provide outside diameter as specified in ASTM F 1043 for round steel pipe.

2.3.4 Wood Posts

Wood posts shall be cut from sound and solid trees free from short or reverse bends in more than one plane. Tops shall be convex rounded or inclined. Posts shall be free of ring shake, season cracks more than 1/4 inch wide, splits in the end, and unsound knots. Size and shape of posts shall be as indicated. Posts shall be treated in accordance with AWPA C1 or AWPA C4 as applicable.

2.4 BRACES AND RAILS

****

NOTE: Normally rails will not be specified except where appearance is important and the added cost is justified. When top rails are not specified, top tension wire will be used. Bottom tension wire will be specified unless a bottom rail is required for high security fence.

****

ASTM F 1083, zinc-coated, Group IA, steel pipe, size NPS 1-1/4. Group IC steel pipe, zinc-coated, shall meet the strength and coating requirements of ASTM F 1043. Group II , formed steel sections, size 1-21/32 inch, conforming to ASTM F 1043, may be used as braces and rails if Group II line posts are furnished.

2.5 WIRE

2.5.1 Tension Wire

Tension wire shall be Type I or Type II, Class 2 coating, in accordance with ASTM A 824.

2.5.2 Barbed Wire for Farm Style Fence

Barbed wire shall conform to ASTM A 121 [uncoated] [zinc-coated] [copper-coated], class 1, 13 gauge wire with 13-1/2 gauge 4-point barbs spaced no more than 6 inches apart.

2.6 ACCESSORIES

****

NOTE: Clips are not allowed on security fences.

****

ASTM F 626. Ferrous accessories shall be zinc or aluminum coated. Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Barbed wire shall be 2 strand, 12-1/2 gauge wire, zinc-coated, Class 3 in accordance with ASTM A 121 or aluminum coated Type I in accordance with ASTM A 585. Barbed wire shall be four-point barbed type steel wire. Barbed wire support arms shall be the [single] [V] arm type and of the design required for the post furnished. Tie wire for attaching fabric to rails, braces, and posts shall be 9 gauge steel wire and match the coating of the fence fabric. Miscellaneous hardware coatings shall conform to ASTM A 153/A 153M unless modified.

2.7 BARBED TAPE

Reinforced barbed tape, [double coil] [single coil], for fence toppings shall be fabricated from 430 series stainless steel with a hardness range of Rockwell (30N) 37-45 conforming to the requirements of ASTM A 176. The stainless steel strip shall be 0.025 inch thick by 1 inch wide before fabrication. Each barb shall be a minimum of 1.2 inch in length, in groups of 4, spaced on 4 inch centers. The stainless steel core wire shall have a 0.098 inch diameter with a minimum tensile strength of 140 psi and shall be in accordance with ASTM A 478. [Reinforced barbed tape, single coil, for ground application shall meet the above requirements.] [Non-reinforced barbed tape, single coil, for ground applications shall be fabricated from 301 series stainless steel, with a hardness range of Rockwell (30N) 50-55, in accordance with ASTM A 666. The stainless steel strip shall be 0.025 inch thick by 1.21 inches wide before fabrication. Each barb shall be a minimum of 1.2 inch in length, in groups of 4, spaced on 4 inch centers.] Sixteen gauge stainless steel twistable wire ties shall be used for attaching the barbed tape to the barbed wire [and to the fence for ground application].

2.8 CONCRETE

ASTM C 94, using 3/4 inch maximum size aggregate, and having minimum compressive strength of 3000 psi at 28 days. Grout shall consist of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

2.9 PADLOCKS

****

NOTE: Type P01 is key operated. Grade 6 is the top grade commercial lock; in Option A the key is capitive in cylinder when padlock is unlocked; in Option B the cylinder is removable; Option 6 is environmentaly resistant. For combination locks or other options and grades see ASTM F 883.

****

Padlocks shall conform to ASTM F 883, Type [PO1] [_____], Option[s] [A, B, and G] [_____] [and] [_____], Grade [6] [_____]. [EPB], Size 1-3/4 inch. [Allpadlocks shall be keyed alike]. [All padlocks shall be keyed into master key system as specified in Section 08700BUILDERS' HARDWARE].

2.10 GATE OPERATOR

Electric gate operators for sliding gates shall be as follows: Electrical gate operators shall have a right angle gearhead instantly reversing motor with magnetic drum-type brake, friction disc clutch, reversing starter with thermal overload protection, and a chain-driven geared rotary-type automatic limit switch. Gears shall consist of a hardened steel machine cut worm and mating bronze gear. All gears and bearings shall operate in a bath of oil. Gate operators with V-belt pulleys will not be allowed. Gate operators shall be equipped with an emergency release to allow the gate to be operated manually. The emergency release mechanism shall be capable of being locked in the engaged or disengaged position. Positive stops shall be provided on the gate tracks as a backup to the limit switches.

2.11 ELECTRO-MECHANICAL LOCKS

Electro-mechanical locking devices for sliding gates and personnel gates shall be solenoid actuated such that the deadbolt retracts when the solenoid is energized and remains electrically retracted until the gate is closed. The solenoid shall be the continuous duty type, rated for 120V ac, 60Hz operation. The locking device shall be unlockable by key and shall be keyed on both sides. Status of the electro-mechanical lock shall be monitored by two limit switches (integral to the locking device) wired in series. One switch shall monitor the deadlock lever and the other switch shall monitor the locking tongue.

PART 3   EXECUTION

3.1   INSTALLATION

****

NOTE: For farm style fence, the layout will be shown and will include fence section, height, mesh size, locations of straight-line and corner-post bracing, types and locations of gates, and gate sizes. Drawings will also indicate the extent of clearing required. Fences will not be located adjacent to natural or man-made terrain features that could provide easy access across the fence. The graded fence line will be indicated on the drawings where required.

****

Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared to the extent indicated. Line posts shall be spaced equidistant at intervals not exceeding 10 feet. Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 500 feet. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A 780.

3.2   EXCAVATION

Post holes shall be cleared of loose material. Waste material shall be spread where directed. The ground surface irregularities along the fence line shall be eliminated to the extent necessary to maintain a [1] [2] inch clearance between the bottom of the fabric and finish grade.

3.3   POST INSTALLATION

3.3.1   Posts for Chain Link Fence

****

NOTE: For fences over 1.83 m (6 feet) tall in areas of frequent high winds (113 kph (70 mph) or greater), hole diameters of 406 mm (16 inches) for terminal posts and 305 mm (12 inches) for line posts will be specified.

****

Posts shall be set plumb and in alignment. Except where solid rock is encountered, posts shall be set in concrete to the depth indicated on the drawings. Where solid rock is encountered with no overburden, posts shall be set to a minimum depth of 18 inches in rock. Where solid rock is covered with an overburden of soil or loose rock, posts shall be set to the minimum depth indicated on the drawing unless a penetration of 18 inches in solid rock is achieved before reaching the indicated depth, in which case depth of penetration shall terminate. All portions of posts set in rock shall be grouted. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Posts set in concrete shall be set in holes not less than the diameter shown on the drawings. Diameters of holes in solid rock shall be at least 1 inch greater than the largest cross section of the post. Concrete and grout shall be thoroughly consolidated around each post, shall be free of voids and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts. Group II line posts may be mechanically driven, for temporary fence construction only, if rock is not encountered. Driven posts shall be set to a minimum depth of 3 feet and shall be protected with drive caps when being set. For high security fences, fence post rigidity shall be tested by applying a 50 pound force on the post, perpendicular to the fabric, at 5 feet above ground; post movement measured at the point where the force is applied shall be less than or equal to 3/4 inch from the relaxed position; every tenth post shall be tested for rigidity; when a post fails this test, further tests on the next four posts on either side of the failed post shall be made; all failed posts shall be removed, replaced, and retested at the Contractor's expense.

3.3.2 Posts for Farm Style Fence

For wood posts, the Contractor shall excavate to depth indicated and brace post until backfill is completed. Backfill shall be placed in layers of 9 inches or less, moistened to optimum condition, and compacted with hand tampers or other approved method. Posts shall be set plumb and in proper alignment. Metal posts shall be driven or set in concrete as indicated.

3.4 RAILS

3.4.1 Top Rail

****

NOTE: Top rail will not be used on high security fences.

****

Top rail shall be supported at each post to form a continuous brace between terminal posts. Where required, sections of top rail shall be joined using sleeves or couplings that will allow expansion or contraction of the rail. Top rail, if required for high security fence, shall be installed as indicated on the drawings.

3.4.2 Bottom Rail

****

NOTE: This paragraph applies to high security fence applications only.

****

The bottom rail shall be bolted to double rail ends and double rail ends shall be securely fastened to the posts. Bolts shall be peened to prevent easy removal. Bottom rail shall be installed before chain link fabric.

3.5 BRACES AND TRUSS RODS

Braces and truss rods shall be installed as indicated and in conformance with the standard practice for the fence furnished. Horizontal (compression) braces and diagonal truss (tension) rods shall be installed on fences over 6 feet in height. A center brace or 2 diagonal truss rods shall be installed on 12 foot fences. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal. No bracing is required on fences 6 feet high or less if a top rail is installed.

3.6 TENSION WIRES

****

NOTE: For high security fence, the tension wire will be installed within the top 100 mm (4 inches) of the installed fabric.

****

Tension wires shall be installed along the [top and] [bottom] of the fence line and attached to the terminal posts of each stretch of the fence. Top tension wires shall be installed within the top [1 foot][4 inches] of the installed fabric. Bottom tension wire shall be installed within the bottom 6 inches of the installed fabric. Tension wire shall be pulled taut and shall be free of sag.

3.7 CHAIN LINK FABRIC

****

NOTE: Normally the bottom of fence fabric will be installed no higher than 50.8 mm (2 inches) from the ground. For Air Force projects, high security fence fabric will be installed no higher than 25 mm (1 inch) from the ground. The height requirement for fence fabric will be verified with the user. In areas where the soil along the fence line is prone to erosion, measures should be taken to maintain the level of security for which the fence is designed. Tension requirements are for high security fence applications. Fabric fastening requirement of 305 mm (12 inch) spacing to top tension wire and bottom rail is a high security fence requirement.

****

Chain link fabric shall be installed on the side of the post indicated. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be spaced at approximately 15 inch intervals. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at approximately 15 inch intervals and fastened to all rails and tension wires at approximately [24][12] inch intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be [2][1] plus or minus 1/2 inch above the ground. For high security fence, after the fabric installation is complete, the fabric shall be exercised by applying a 50 pound push-pull force at the center of the fabric between posts; the use of a 30 pound pull at the center of the panel shall cause fabric deflection of not more than 2-1/2 inches when pulling fabric from the post side of the fence; every second fence panel shall meet this requirement; all failed panels shall be resecured and retested at the Contractor's expense.

3.8 BARBED WIRE SUPPORTING ARMS AND BARBED WIRE

3.8.1 General Requirements

****

NOTE: Supporting arms for high security fence applications will be securely anchored with rivets to the line posts.

****

Barbed wire supporting arms and barbed wire shall be installed as indicated and as recommended by the manufacturer. Supporting arms shall be anchored [to the posts in a manner to prevent easy removal with hand tools] [with 3/8 inch diameter plain pin rivets or, at the Contractor's option, with studs driven by low-velocity explosive-actuated tools for steel, wrought iron, ductile iron, or malleable iron. Studs driven by an explosive-actuated tool shall not be used with gray iron or other material that can be fractured. A minimum of two studs per support arm shall be used.] Barbed wire shall be pulled taut and attached to the arms with clips or other means that will prevent easy removal.

3.8.2 Barbed Wire for Farm Style Fence

Wire shall be installed on the side of the post indicated. Wire shall be pulled taut to provide a smooth uniform appearance, free from sag. Wire shall be fastened to line posts at approximately 15 inch intervals unless indicated otherwise.

3.9 GATE INSTALLATION

Gates shall be installed at the locations shown. Hinged gates shall be mounted to swing as indicated. Latches, stops, and keepers shall be installed as required. [Slide] [Lift] gates shall be installed as recommended by the manufacturer. Padlocks shall be attached to gates or gate posts with chains. Hinge pins, and hardware shall be welded or otherwise secured to prevent removal. For farm style fencing, standard metal gate assemblies with frame and fittings necessary for complete installation or wood gates shall be furnished as shown.

3.10 BARBED TAPE INSTALLATION

****

NOTE: Barbed tape is a high security fence option when required.

****

Stainless steel reinforced barbed tape shall be installed as detailed on the drawings. Barbed tape shall be stretched out to its manufacturer's recommended length, set on top of the barbed wire and "V" shaped support arms, and then secured to the barbed wire. The barbed tape shall be secured to the barbed wire at the two points and at every spiral turn of both coils as shown on the drawings. Stainless steel [reinforced] [non-reinforced] barbed tape for ground applications shall be installed [per manufacturer's recommendations] [as shown on the drawings].

3.11 GROUNDING

****

NOTE: Delete this paragraph if grounding is not required. If grounding is required and lightning protection is not part of project design, the requirements in the second set of brackets will be used in lieu of those in the first set of brackets. Provide fence grounding details when composite type posts are specified where grounding of the fence is required.

****

[Fences crossed by overhead powerlines in excess of 600 volts shall be grounded as specified in Section 13100 LIGHTNING PROTECTION SYSTEM. Electrical equipment attached to the fence shall be grounded as specified in [Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL] [Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND].] [Fences shall be grounded on each side of all gates, at each corner, at the closest approach to each building located within 50 feet of the fence, and where the fence alignment changes more than 15 degrees. Grounding locations shall not exceed 650 feet. Each gate panel shall be bonded with a flexible bond strap to its gate post. Fences crossed by powerlines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 150 feet on each side of crossing. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be 3/4 inch by 10 foot long copper-clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 6 inches below the grade. Where driving is impracticable, electrodes shall be buried a minimum of 12 inches deep and radially from the fence. The top of the electrode shall be not less than 2 feet or more than 8 feet from the fence. Ground conductor shall be clamped to the fence and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence fabric, and ground rods. After installation the total resistance of fence to ground shall not be greater than 25 ohms.]

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02921 (June 1998)**
U.S. ARMY CORPS OF ENGINEERS **----------------------**
Superseding
CEGS-02935 (June 1990)

GUIDE SPECIFICATION FOR CONSTRUCTION

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DEPARTMENT OF THE ARMY | **CEGS-02921 (June 1998)**
U.S. ARMY CORPS OF ENGINEERS | **----------------------**
Superseding
CEGS-02935 (June 1990)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02921

SEEDING
06/98

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NOTE: This guide specification covers the requirements for installing seed. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

****

NOTE: Areas to be seeded must be shown or defined in the project drawings, and if more than one method of installing seed is specified, drawings will delineate areas for each method.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AGRICULTURAL MARKETING SERVICE (AMS)

AMS-01	(Aug 95) Federal Seed Act Regulations Part 201

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 602	(1995a) Agricultural Liming Materials
ASTM D 977	(1991) Emulsified Asphalt
ASTM D 2028	(1976; R 1992) Cutback Asphalt (Rapid-Curing Type)
ASTM D 4972	(1995a) pH of Soils
ASTM D 5268	(1992; R 1996) Topsoil Used for Landscaping Purposes
ASTM D 5883	(1996) Standard Guide for Use of Rotary Kiln Produced Expanded Shale, Clay or Slate (ESCS) as a Mineral Amendment in Topsoil Used for Landscaping and Related Purposes

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment; [_____]. Surface Erosion Control Material; [_____]. Chemical Treatment Material; [_____].

Manufacturer's literature including physical characteristics, application and installation instructions for equipment, surface erosion control material and chemical treatment material.

SD-07 Schedules

Equipment; [_____].

A listing of equipment to be used for the seeding operation.

SD-08 Statements

Delivery; [_____].

Delivery schedule.

Finished Grade and Topsoil; [_____].

Finished grade status.

Topsoil; [_____].

Availability of topsoil from the stripping and stock piling operation.

SD-09 Reports

Equipment Calibration; [_____].

Certification of calibration tests conducted on the equipment used in the seeding operation.

Soil Test; [_____].

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

SD-13 Certificates

Seed; [_____]. Topsoil; [_____]. pH Adjuster; [_____]. Fertilizer; [_____]. Organic Material; [_____]. Soil Conditioner; [_____]. Mulch; [_____]. Asphalt Adhesive; [_____]. Pesticide; [_____].

Prior to the delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following:

a. Seed. Classification, botanical name, common name, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, and date tested.

b. Topsoil. Particle size, pH, organic matter content, textural class, soluble salts, chemical and mechanical analyses.

c. pH Adjuster. Calcium carbonate equivalent and sieve analysis.

d. Fertilizer. Chemical analysis and composition percent.

e. Organic Material: Composition and source.

f. Soil Conditioner: Composition and source.

g. Mulch: Composition and source.

h. Asphalt Adhesive: Composition.

i. Pesticide. EPA registration number and registered uses.

SD-14 Samples

Delivered Topsoil; [_____].

Samples taken from several locations at the source.

Soil Amendments; [_____].

A 10 pound sample.

Mulch; [_____].

A 10 pound sample.

SD-18 Records

Quantity Check; [_____].

Bag count or bulk weight measurements of material used compared with area covered to determine the application rate and quantity installed.

Seed Establishment Period; [_____].

Calendar time period for the seed establishment period. When there is more than one seed establishment period, the boundaries of the seeded area covered for each period shall be described.

Maintenance Record; [_____].

Maintenance work performed, area repaired or reinstalled, diagnosis for unsatisfactory stand of grass plants.

Application of Pesticide; [_____].

Pesticide treatment plan with sequence of treatment work with dates and times. The pesticide trade name, EPA registration number, chemical composition, formulation, concentration of original and diluted material, application rate of active ingredients, method of application, area treated, amount applied; and the name and state license number of the state certified applicator shall be included.

1.3 SOURCE INSPECTION

The source of delivered topsoil shall be subject to inspection.

1.4 DELIVERY, INSPECTION, STORAGE, AND HANDLING

1.4.1 Delivery

A delivery schedule shall be provided at least 10 calendar days prior to the first day of delivery.

1.4.1.1 Delivered Topsoil

Prior to the delivery of any topsoil, its availability shall be verified in paragraph TOPSOIL. A soil test shall be provided for topsoil delivered to the site.

1.4.1.2 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

1.4.1.3 Pesticides

Pesticide material shall be delivered to the site in the original, unopened containers bearing legible labels indicating the EPA registration number and the manufacturer's registered uses.

1.4.2 Inspection

Seed shall be inspected upon arrival at the job site for conformity to species and quality. Seed that is wet, moldy, or bears a test date five months or older, shall be rejected. Other materials shall be inspected for compliance with specified requirements. The following shall be rejected: open soil amendment containers or wet soil amendments; topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 1-1/2 inch diameter; and topsoil that contains viable plants and plant parts. Unacceptable materials shall be removed from the job site.

1.4.3 Storage

Materials shall be stored in designated areas. Seed, lime, and fertilizer shall be stored in cool, dry locations away from contaminants. Chemical treatment material shall be stored according to manufacturer's instructions and not with seeding operation materials.

1.4.4 Handling

Except for bulk deliveries, materials shall not be dropped or dumped from vehicles.

1.4.5 Time Limitation

Hydroseeding time limitation for holding seed in the slurry shall be a maximum 24 hours.

PART 2 PRODUCTS

****

NOTE: Check with local Agriculture Extension Service, State Agricultural Experimental Station, local university, Turfgrass Producers International (TPI) or other reputable source to determine the proper species to specify; the proper establishment season; seed installation procedures; application rates for the soil amendments; and other installation requirements particular to the project area. Each state Department of Transportation has

standard seed mixtures which should be considered.
****

2.1 SEED

****
NOTE: State-certified seed is more stringently monitored than State-approved seed; and therefore, more expensive.
****

2.1.1 Seed Classification

[State-certified] [State-approved] seed of the latest season's crop shall be provided in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with AMS-01 and applicable state seed laws.

2.1.2 Permanent Seed Species and Mixtures

****
NOTE: Label the seed mixtures to be installed in the lawn area and field area. Lawn areas are highly maintained and have frequent mowing. Field areas are low maintenance with a minimum of 1 mowing per season.
****

Permanent seed species and mixtures shall be proportioned by weight as follows:

Botanical Name	Common Name	Mixture Percent by Weight	Percent Pure Live Seed
		LAWN SEED	
[_____]	[_____]	[_____]	[_____]
		FIELD SEED	
[_____]	[_____]	[_____]	[_____]

2.1.3 Temporary Seed Species

Temporary seed species for surface erosion control or overseeding shall be as follows:

Botanical Name	Common Name	Percent Pure Live Seed
[_____]	[_____]	[_____]

2.1.4 Quality

Weed seed shall be a maximum 1 percent by weight of the total mixture.

2.1.5 Seed Mixing

The mixing of seed may be done by the seed supplier prior to delivery, or on site as directed.

2.1.6 Substitutions

Substitutions will not be allowed without written request and approval from the Contracting Officer.

2.2 TOPSOIL

****

NOTE: Stockpiled topsoil is limited and the areas that will use the soil need to be defined. If suitable topsoil is not available within the limits of the work area, consider the economics of amending the existing soil in the smooth graded areas with fertilizer and soil amendments versus transporting topsoil to the project site. If amending the existing soil is more economical, establish the requirements for fertilizer and soil amendments.

****

Topsoil shall be as defined in ASTM D 5268. When available, the topsoil shall be the existing surface soil stripped and stockpiled onsite in accordance with Section 02300 EARTHWORK. When additional topsoil is required beyond the available topsoil from the stripping operation, topsoil shall be delivered and amended as recommended by the soil test for the seed specified. Topsoil shall be free from slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 1-1/2 inch diameter. Topsoil shall be free from viable plants and plant parts.

2.3 SOIL AMENDMENTS

****

NOTE: Soil amendments are materials necessary for individual plant health requirements which are incorporated into the native soils during the seeding operation.

Field experience may be used to choose soil amendments to meet the local growing conditions on the project site.

****

Soil amendments shall consist of pH adjuster, fertilizer, organic material and soil conditioners meeting the following requirements. Vermiculite shall not be used.

2.3.1 pH Adjuster

The pH adjuster shall be an agricultural liming material in accordance with ASTM C 602. These materials may be burnt lime, hydrated lime, ground limestone, sulfur, or shells. The pH adjuster shall be used to create a favorable soil pH for the plant material specified.

2.3.1.1 Limestone

Limestone material shall contain a minimum calcium carbonate equivalent of 80 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 55 percent shall pass through a No. 60 sieve. To raise soil pH, ground limestone shall be used.

2.3.1.2 Hydrated Lime

Hydrated lime shall contain a minimum calcium carbonate equivalent of 110 percent. Gradation: A minimum 100 percent shall pass through a No. 8 sieve and a minimum 97 percent shall pass through a No. 60 sieve.

2.3.1.3 Burnt Lime

Burnt lime shall contain a minimum calcium carbonate equivalent of 140 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 35 percent shall pass through a No. 60 sieve.

2.3.2 Fertilizer

****

NOTE: Phosphorous is the chemical most responsible for vigorous root growth. Recommended slow release fertilizers should provide a 3-4-1 nutrient ratio; For example 18-24-6.

****

[It shall be as recommended by the soil test] [The nutrients ratio shall be [_____] percent nitrogen, [_____] percent phosphorus, and [_____] percent potassium]. Fertilizer shall be controlled release commercial grade, free flowing, uniform in composition, and consist of a nitrogen-phosphorus-potassium ratio. The fertilizer shall be derived from sulphur coated urea, urea formaldehyde, plastic or polymer coated pills, or isobutylenediurea (IBDU). Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients.

2.3.3 Nitrogen Carrier Fertilizer

[It shall be as recommended by the soil test] [The nutrients ratio shall be [_____] percent nitrogen, [_____] percent phosphorus, and [_____] percent potassium]. Nitrogen carrier fertilizer shall be commercial grade, free flowing, and uniform in composition. The fertilizer may be a liquid nitrogen solution.

2.3.4 Organic Material

Organic material shall consist of either bonemeal, rotted manure, decomposed wood derivatives, recycled compost, or worm castings.

2.3.4.1 Bonemeal

Bonemeal shall be finely ground, steamed bone product containing from 2 to 4 percent nitrogen and 16 to 40 percent phosphoric acid.

2.3.4.2 Rotted Manure

Rotted manure shall be unleached horse, chicken or cattle manure containing a maximum 25 percent by volume of straw, sawdust, or other bedding materials. It shall contain no chemicals or ingredients harmful to plants. The manure shall be heat treated to kill weed seeds and be free of stones, sticks, and soil.

2.3.4.3 Decomposed Wood Derivatives

Decomposed wood derivatives shall be ground bark, sawdust, yard trimmings, or other wood waste material that is free of stones, sticks, soil, and toxic substances harmful to plants, and is fully composted or stabilized with nitrogen.

2.3.4.4 Recycled Compost

Compost shall be a well decomposed, stable, weed free organic matter source. Compost shall be derived from food; agricultural or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. The compost shall possess no objectionable odors and shall not resemble the raw material from which it was derived. The material shall not contain substances toxic to plants. Gradation: The compost material shall pass through a 3/8 inch screen, possess a pH of 5.5 to 8.0, and have a moisture content between 35-55 percent by weight. The material shall not contain more than 1 percent by weight of man-made foreign matter. Compost shall be cleaned of plastic materials larger than 2 inches in length.

2.3.4.5 Worm Castings

Worm castings shall be screened from worms and food source, and shall be commercially packaged.

2.3.5 Soil Conditioner

****

NOTE: Soil conditioners are inorganic materials used to alter the chemical or physical characteristics of the soil.

****

Soil conditioner shall be sand, super absorbent polymers, calcined clay, or gypsum for use singly or in combination to meet the requirements of the soil test.

2.3.5.1 Sand

Sand shall be clean and free of toxic materials. Gradation: A minimum 95 percent by weight shall pass a No. 10 sieve and a minimum 10 percent by weight shall pass a No. 16 sieve. Greensand shall be balanced with the inclusion of trace minerals and nutrients.

2.3.5.2 Super Absorbent Polymers

To improve water retention in soils, super absorbent polymers shall be sized and applied according to the manufacturer's recommendations. Polymers shall be added as a soil amendment and be cross-linked polyacrylamide, with an absorption capacity of 250-400 times its weight. Polymers shall also be added to the seed and be a starch grafted polyacrylonitrite, with graphite added as a tacky sticker. It shall have an absorption capacity of 100 plus times its weight.

2.3.5.3 Calcined Clay

Calcined clay shall be granular particles produced from montmorillonite clay calcined to a minimum temperature of 1200 degrees F. Gradation: A minimum 90 percent shall pass a No. 8 sieve; a minimum 99 percent shall be retained on a No. 60 sieve; and a maximum 2 percent shall pass a No. 100 sieve. Bulk density: A maximum 40 pounds per cubic foot.

2.3.5.4 Gypsum

Gypsum shall be commercially packaged, free flowing, and a minimum 95 percent calcium sulfate by volume.

2.3.5.5 Expanded Shale, Clay, or Slate (ESCS)

Rotary kiln produced ESCS material shall be in conformance with ASTM D 5883.

2.4 MULCH

Mulch shall be free from weeds, mold, and other deleterious materials. Mulch materials shall be native to the region.

2.4.1 Straw

Straw shall be stalks from oats, wheat, rye, barley, or rice, furnished in air-dry condition and with a consistency for placing with commercial mulch-blowing equipment.

2.4.2 Hay

Hay shall be native hay, sudan-grass hay, broomsedge hay, or other herbaceous mowings, furnished in an air-dry condition suitable for placing with commercial mulch-blowing equipment.

2.4.3 Wood Cellulose Fiber

Wood cellulose fiber shall not contain any growth or germination-inhibiting factors and shall be dyed an appropriate color to facilitate placement during application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 4.5 to 6.0.

2.4.4 Paper Fiber

Paper fiber mulch shall be recycled news print that is shredded for the purpose of mulching seed.

2.5 ASPHALT ADHESIVE

Asphalt adhesive shall conform to the following: Emulsified asphalt, conforming to ASTM D 977, Grade SS-1; and cutback asphalt, conforming to ASTM D 2028, Designation RC-70.

2.6 WATER

****

NOTE: When water is Government-furnished, locate

the source.
****

Water shall be the responsibility of the Contractor, unless otherwise noted. Water shall not contain elements toxic to plant life.

2.7 PESTICIDE

Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide or miticide. For the purpose of this specification, a soil fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved.

2.8 SURFACE EROSION CONTROL MATERIAL

****
NOTE: The Contractor may propose other types of surface erosion control material, based on site conditions.
****

Surface erosion control material shall conform to the following:

2.8.1 Surface Erosion Control Blanket

Blanket shall be machine produced mat of wood excelsior formed from a web of interlocking wood fibers; covered on one side with either knitted straw blanket-like mat construction; covered with biodegradable plastic mesh; or interwoven biodegradable thread, plastic netting, or twisted kraft paper cord netting.

2.8.2 Surface Erosion Control Fabric

Fabric shall be knitted construction of polypropylene yarn with uniform mesh openings 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips shall have a minimum life of 6 months.

2.8.3 Surface Erosion Control Net

Net shall be heavy, twisted jute mesh, weighing approximately 1.22 pounds per linear yard and 4 feet wide with mesh openings of approximately 1 inch square.

2.8.4 Surface Erosion Control Chemicals

Chemicals shall be high-polymer synthetic resin or cold-water emulsion of selected petroleum resins.

2.8.5 Hydrophilic Colloids

Hydrophilic colloids shall be physiologically harmless to plant and animal life without phytotoxic agents. Colloids shall be naturally occurring, silicate powder based, and shall form a water insoluble membrane after curing. Colloids shall resist mold growth.

2.8.6 Erosion Control Material Anchors

Erosion control anchors shall be as recommended by the manufacturer.

PART 3 EXECUTION

3.1 INSTALLING SEED TIME AND CONDITIONS

****

NOTE: Specify seeding times as determined by field experience or as recommended by the Department of Agriculture County Extension Service for the species specified and to meet local growing conditions.

****

3.1.1 Seeding Time

Seed shall be installed from [_____] to [_____] for spring establishment; from [_____] to [_____] for summer establishment; and from [_____] to [_____] for fall establishment.

3.1.2 Seeding Conditions

Seeding operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the seeding operations, proposed alternate times shall be submitted for approval.

3.1.3 Equipment Calibration

Immediately prior to the commencement of seeding operations, calibration tests shall be conducted on the equipment to be used. These tests shall confirm that the equipment is operating within the manufacturer's specifications and will meet the specified criteria. The equipment shall be calibrated a minimum of once every day during the operation. The calibration test results shall be provided within 1 week of testing.

3.1.4 Soil Test

Delivered topsoil, existing soil in smooth graded areas, and stockpiled topsoil shall be tested in accordance with ASTM D 5268 and ASTM D 4972 for determining the particle size, pH, organic matter content, textural class, chemical analysis, soluble salts analysis, and mechanical analysis. Sample collection on site shall be random over the entire site. Sample collection for stockpiled topsoil shall be at different levels in the stockpile. The soil shall be free from debris, noxious weeds, toxic substances, or other materials harmful to plant growth. The test shall determine the quantities and type of soil amendments required to meet local growing conditions for the seed species specified.

3.2 SITE PREPARATION

3.2.1 Finished Grade and Topsoil

****

NOTE: Coordinate the placement of topsoil with Section 02300 EARTHWORK. When stockpiled topsoil is limited, define the areas that will use this soil. It is not necessary to topsoil all areas to be seeded; the smooth graded areas can be amended with soil amendments to meet local growing conditions for

the seed specified. This procedure may be more cost effective. Coordinate the topsoil requirements with Sections 02922 SODDING, 02923 SPRIGGING, and 02930 EXTERIOR PLANTING.
****

The Contractor shall verify that finished grades are as indicated on drawings, and the placing of topsoil, smooth grading, and compaction requirements have been completed in accordance with Section 02300 EARTHWORK, prior to the commencement of the seeding operation.

3.2.2 Application of Soil Amendments

****
NOTE: If more than one pH adjuster, fertilizer or soil conditioner is specified, an application rate will be provided for each material.
****

3.2.2.1 Applying pH Adjuster

[The pH adjuster shall be applied as recommended by the soil test] [The application rate shall be [_____] pounds per 1000 square yards]. The pH adjuster shall be incorporated into the soil to a maximum 4 inch depth or may be incorporated as part of the tillage operation.

3.2.2.2 Applying Fertilizer

[The fertilizer shall be applied as recommended by the soil test] [The application rate shall be [_____] pounds per 1000 square yards]. Fertilizer shall be incorporated into the soil to a maximum 4 inch depth or may be incorporated as part of the tillage or hydroseeding operation.

3.2.2.3 Applying Soil Conditioner

[The soil conditioner shall be as recommended by the soil test] [The application rate shall be [_____] pounds per 1000 square yards]. The soil conditioner shall be spread uniformly over the soil a minimum 1 inch depth and thoroughly incorporated by tillage into the soil to a maximum 4 inch depth.

3.2.2.4 Applying Super Absorbent Polymers

Polymers shall be spread uniformly over the soil as recommended by the manufacturer and thoroughly incorporated by tillage into the soil to a maximum 4 inch depth.

3.2.3 Tillage

Soil on slopes up to a maximum 3-horizontal-to-1-vertical shall be tilled to a minimum 4 inch depth. On slopes between 3-horizontal-to-1-vertical and 1-horizontal-to-1 vertical, the soil shall be tilled to a minimum 2 inch depth by scarifying with heavy rakes, or other method. Rototillers shall be used where soil conditions and length of slope permit. On slopes 1-horizontal-to-1 vertical and steeper, no tillage is required. Drainage patterns shall be maintained as indicated on drawings. Areas compacted by construction operations shall be completely pulverized by tillage. Soil used for repair of surface erosion or grade deficiencies shall conform to topsoil requirements. The pH adjuster, fertilizer, and soil conditioner may be applied during this procedure.

3.2.4 Prepared Surface

3.2.4.1 Preparation

The prepared surface shall be a maximum 1 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be completed with a light raking to remove debris.

3.2.4.2 Lawn Area Debris

Debris and stones over a minimum 5/8 inch in any dimension shall be removed from the surface.

3.2.4.3 Field Area Debris

****

NOTE: Provide for prepared surface of areas not requiring fine raking to remove debris and stones larger than 16 mm (5/8 inch). This procedure may be more cost effective for areas not requiring a lawn finish.

****

Debris and stones over a minimum 3 inch in any dimension shall be removed from the surface.

3.2.4.4 Protection

Areas with the prepared surface shall be protected from compaction or damage by vehicular or pedestrian traffic and surface erosion.

3.3 INSTALLATION

****

NOTE: Allow the Contractor seed installation options when installing areas larger than one acre. Label seeding rates to be used for lawn areas and for field areas. Define lawn areas and field areas on the drawings.

****

Prior to installing seed, any previously prepared surface compacted or damaged shall be reworked to meet the requirements of paragraph SITE PREPARATION. Seeding operations shall not take place when the wind velocity will prevent uniform seed distribution.

3.3.1 Installing Seed

Seeding method shall be [Broadcast Seeding] [Drill Seeding] [Hydroseeding]. Seeding procedure shall ensure even coverage. Gravity feed applicators, which drop seed directly from a hopper onto the prepared soil, shall not be used because of the difficulty in achieving even coverage, unless otherwise approved. Absorbent polymer powder shall be mixed with the dry seed at the rate recommended by the manufacturer.

3.3.1.1   Broadcast Seeding

Seed shall be uniformly broadcast at the rate of [_____] pounds per 1000 square feet using broadcast seeders. Half the total rate of seed application shall be broadcast in 1 direction, with the remainder of the seed rate broadcast at 90 degrees from the first direction. Seed shall be covered a maximum 1/4 inch depth by disk harrow, steel mat drag, cultipacker, or other approved device.

3.3.1.2   Drill Seeding

Seed shall be uniformly drilled to a maximum 1/2 inch depth and at the rate of [_____] pounds per 1000 square feet, using equipment having drills a maximum 7 inches distance apart. Row markers shall be used with the drill seeder. Half the total rate of seed application shall be drilled in 1 direction, with the remainder of the seed rate drilled at 90 degrees from the first direction. The drilling equipment shall be maintained with half full seed boxes during the seeding operations.

3.3.1.3   Rolling

The entire area shall be firmed with a roller not exceeding 90 pounds per foot roller width. Slopes over a maximum 3-horizontal-to-1 vertical shall not be rolled. Areas seeded with seed drills equipped with rollers shall not be rolled.

3.3.2   Hydroseeding

****

NOTE: Retain bracketed sentence only when wood cellulose fiber will be used for mulch.

****

Seed shall be mixed to ensure broadcast at the rate of [_____] pounds per 1000 square feet. Seed and fertilizer shall be added to water and thoroughly mixed to meet the rates specified. The time period for the seed to be held in the slurry shall be a maximum 24 hours. [Wood cellulose fiber mulch and tackifier shall be added at the rates recommended by the manufacturer after the seed, fertilizer, and water have been thoroughly mixed to produce a homogeneous slurry.] Slurry shall be uniformly applied under pressure over the entire area. The hydroseeded area shall not be rolled.

3.3.3   Mulching

3.3.3.1   Hay or Straw Mulch

Hay or straw mulch shall be spread uniformly at the rate of 2 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader, or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch shall not be bunched or clumped. Sunlight shall not be completely excluded from penetrating to the ground surface. All areas installed with seed shall be mulched on the same day as the seeding. Mulch shall be anchored immediately following spreading.

3.3.3.2   Mechanical Anchor

Mechanical anchor shall be a V-type-wheel land packer; a scalloped-disk land packer designed to force mulch into the soil surface; or other suitable equipment.

3.3.3.3 Asphalt Adhesive Tackifier

Asphalt adhesive tackifier shall be sprayed at a rate between 10 to 13 gallons per 1000 square feet. Sunlight shall not be completely excluded from penetrating to the ground surface.

3.3.3.4 Non-Asphaltic Tackifier

Hydrophilic colloid shall be applied at the rate recommended by the manufacturer, using hydraulic equipment suitable for thoroughly mixing with water. A uniform mixture shall be applied over the area.

3.3.3.5 Asphalt Adhesive Coated Mulch

Hay or straw mulch may be spread simultaneously with asphalt adhesive applied at a rate between 10 to 13 gallons per 1000 square feet, using power mulch equipment which shall be equipped with suitable asphalt pump and nozzle. The adhesive-coated mulch shall be applied evenly over the surface. Sunlight shall not be completely excluded from penetrating to the ground surface.

3.3.3.6 Wood Cellulose Fiber, Paper Fiber, and Recycled Paper

Wood cellulose fiber, paper fiber, or recycled paper shall be applied as part of the hydroseeding operation. The mulch shall be mixed and applied in accordance with the manufacturer's recommendations.

3.3.4 Watering Seed

****

NOTE: Water requirements to establish seed may be greater than for the establishment of exterior plants.

****

Watering shall be started immediately after completing the seeding of an area. Water shall be applied to supplement rainfall at a rate sufficient to ensure moist soil conditions to a minimum 1 inch depth. Run-off and puddling shall be prevented. Watering trucks shall not be driven over turf areas, unless otherwise directed. Watering of other adjacent areas or plant material shall be prevented.

3.4 SURFACE EROSION CONTROL

3.4.1 Surface Erosion Control Material

Where indicated or as directed, surface erosion control material shall be installed in accordance with manufacturer's instructions. Placement of the material shall be accomplished without damage to installed material or without deviation to finished grade.

3.4.2 Temporary Seeding

[The application rate shall be [_____] pounds per 1000 square yards.]

When directed during contract delays affecting the seeding operation or when a quick cover is required to prevent surface erosion, the areas designated shall be seeded in accordance with temporary seed species listed under Paragraph SEED.

3.4.2.1 Soil Amendments

When soil amendments have not been applied to the area, the quantity of 1/2 of the required soil amendments shall be applied and the area tilled in accordance with paragraph SITE PREPARATION. The area shall be watered in accordance with paragraph Watering Seed.

3.4.2.2 Remaining Soil Amendments

The remaining soil amendments shall be applied in accordance with the paragraph Tillage when the surface is prepared for installing seed.

3.5 QUANTITY CHECK

For materials provided in bags, the empty bags shall be retained for recording the amount used. For materials provided in bulk, the weight certificates shall be retained as a record of the amount used. The amount of material used shall be compared with the total area covered to determine the rate of application used. Differences between the quantity applied and the quantity specified shall be adjusted as directed.

3.6 APPLICATION OF PESTICIDE

****

NOTE: When a pest is known to be in the soil, identify the pest and the area to be treated.

****

When application of a pesticide becomes necessary to remove a pest or disease, a pesticide treatment plan shall be submitted and coordinated with the installation pest management program.

3.6.1 Technical Representative

The certified installation pest management coordinator shall be the technical representative, and shall be present at all meetings concerning treatment measures for pest or disease control. They may be present during treatment application.

3.6.2 Application

A state certified applicator shall apply required pesticides in accordance with EPA label restrictions and recommendations. Clothing and personal protective equipment shall be used as specified on the pesticide label. A closed system is recommended as it prevents the pesticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying pesticide shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately. A pesticide plan shall be submitted.

3.7 RESTORATION AND CLEAN UP

3.7.1   Restoration

Existing turf areas, pavements, and facilities that have been damaged from the seeding operation shall be restored to original condition at Contractor's expense.

3.7.2   Clean Up

Excess and waste material shall be removed from the seeded areas and shall be disposed offsite. Adjacent paved areas shall be cleaned.

3.8   PROTECTION OF INSTALLED AREAS

Immediately upon completion of the seeding operation in an area, the area shall be protected against traffic or other use by erecting barricades and providing signage as required, or as directed. Signage shall be in accordance with Section 10430 EXTERIOR SIGNAGE.

3.9   SEED ESTABLISHMENT PERIOD

3.9.1   Commencement

The seed establishment period to obtain a healthy stand of grass plants shall begin on the first day of work under this contract and shall end 3 months after the last day of the seeding operation. Written calendar time period shall be furnished for the seed establishment period. When there is more than 1 seed establishment period, the boundaries of the seeded area covered for each period shall be described. The seed establishment period shall be coordinated with Sections 02922 SODDING, 02923 SPRIGGING, and 02930 EXTERIOR PLANTING. The seed establishment period shall be modified for inclement weather, shut down periods, or for separate completion dates of areas.

3.9.2   Satisfactory Stand of Grass Plants

Grass plants shall be evaluated for species and health when the grass plants are a minimum 1 inch high.

3.9.2.1   Lawn Area

A satisfactory stand of grass plants from the seeding operation for a lawn area shall be a minimum 20 grass plants per square foot. Bare spots shall be a maximum [6] [9] inches square. The total bare spots shall be a maximum 2 percent of the total seeded area.

3.9.2.2   Field Area

A satisfactory stand of grass plants from the seeding operation for a field area shall be a minimum 10 grass plants per square foot. The total bare spots shall not exceed 2 percent of the total seeded area.

3.9.3   Maintenance During Establishment Period

****

NOTE: Check with the State Agricultural Experimental Station, Agricultural Extension Service, or other reputable agency for area specific recommendations on grass heights, and type and

application rate for post-fertilizer
****

Maintenance of the seeded areas shall include eradicating weeds, insects and diseases; protecting embankments and ditches from surface erosion; maintaining erosion control materials and mulch; protecting installed areas from traffic; mowing; watering; and post-fertilization.

3.9.3.1 Mowing

a. Lawn Areas: Lawn areas shall be mowed to a minimum 3 inch height when the turf is a maximum 4 inches high. Clippings shall be removed when the amount cut prevents sunlight from reaching the ground surface.

b. Field Areas: Field areas shall be mowed once during the season to a minimum 3 inch height. Clippings shall be removed when the amount cut prevents sunlight from reaching the ground surface.

3.9.3.2 Post-Fertilization

****
NOTE: This procedure enhances the establishment of the grass plants. Organic fertilizers are typically applied the first month and again in 5 months. The post-fertilizer should provide a 4-1-2 or 6-1-3 nutrient ratio; for example: 16-4-8 or 24-4-12.
****

[The fertilizer shall be applied as recommended by the soil test] [The application rate shall be [_____] pounds per 1000 square yards]. A maximum 1/2 pound per 1000 square feet of actual available nitrogen shall be provided to the grass plants. The application shall be timed prior to the advent of winter dormancy and shall be made without burning the installed grass plants.

3.9.3.3 Pesticide Treatment

Treatment for disease or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE.

3.9.3.4 Repair or Reinstall

Unsatisfactory stand of grass plants and mulch shall be repaired or reinstalled, and eroded areas shall be repaired in accordance with paragraph SITE PREPARATION.

3.9.3.5 Maintenance Record

A record of each site visit shall be furnished, describing the maintenance work performed; areas repaired or reinstalled; and diagnosis for unsatisfactory stand of grass plants.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02922 (June 1998)**
U.S. ARMY CORPS OF ENGINEERS **----------------------**
Superseding
CEGS-02935 (June 1990)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

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06/98

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DEPARTMENT OF THE ARMY **CEGS-02922 (June 1998)**
U.S. ARMY CORPS OF ENGINEERS **----------------------**
Superseding
CEGS-02935 (June 1990)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 02922

SODDING
06/98

****

NOTE: This guide specification covers the requirements for installing sod. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

****

NOTE: Areas to be sodded must be shown or defined in the project drawings, and if more than one method of installing sod is specified, drawings will delineate areas for each method.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 602	(1995a) Agricultural Liming Materials
ASTM D 4972	(1995a) pH of Soils
ASTM D 5268	(1992; R 1996) Topsoil Used for Landscaping Purposes
ASTM D 5883	(1996) Standard Guide for Use of Rotary Kiln Produced Expanded Shale, Clay or Slate (ESCS) as a Mineral Amendment in Topsoil Used for Landscaping and Related Purposes

1.2 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment; [_____]. Chemical Treatment Material; [_____].

Manufacturer's literature including physical characteristics, application and installation instructions for equipment and chemical treatment material.

SD-07 Schedules

Equipment; [_____].

A listing of equipment to be used for the sodding operation.

SD-08 Statements

Delivery; [_____].

Delivery schedule.

Finished Grade and Topsoil; [_____].

Finished grade status.

Topsoil; [_____].

Availability of topsoil from the stripping and stock piling operation.

SD-09 Reports

Equipment Calibration; [_____].

Certification of calibration tests conducted on the equipment used in the sodding operation.

Soil Test; [_____].

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

SD-13 Certificates

Sod; [_____]. Topsoil; [_____]. pH Adjuster; [_____]. Fertilizer; [_____]. Organic Material; [_____]. Soil Conditioner; [_____]. Pesticide; [_____].

Prior to the delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following:

a. Sod. Classification, botanical name, common name, mixture percentage of species, percent purity, quality grade, field location and state certification.

b. Topsoil. Particle size, pH, organic matter content, textural class, soluble salts, chemical and mechanical analyses.

c. pH Adjuster. Calcium carbonate equivalent and sieve analysis.

d. Fertilizer. Chemical analysis and composition percent.

e. Organic Material: Composition and source.

f. Soil Conditioner: Composition and source.

g. Pesticide. EPA registration number and registered uses.

SD-14 Samples

Delivered Topsoil; [_____].

Samples taken from several locations at the source.

Soil Amendments; [_____].

A 10 pound sample.

Temporary Seeding; GA.

Sample of annual seed species and application rate.

SD-18 Records

Quantity Check; [_____].

Bag count or bulk weight measurements of material used compared with area covered to determine the application rate and quantity installed. The quantity of sod used shall be compared against the total area installed.

Sod Establishment Period; [_____].

Calendar time period for the sod establishment period. When there is more than one sod establishment period, the boundaries of the sodded area covered for each period shall be described.

Maintenance Record; [_____].

Maintenance work performed, area repaired or reinstalled, diagnosis for unsatisfactory stand of grass plants.

Application of Pesticide; [_____].

Pesticide treatment plan with sequence of treatment work with dates and times. The pesticide trade name, EPA registration number, chemical composition, formulation, concentration of original and diluted material, application rate of active ingredients, method of application, area treated, amount applied; and the name and state license number of the state certified applicator shall be included.

1.3 SOURCE INSPECTION

The sources of sod material and delivered topsoil shall be subject to inspection.

1.4 DELIVERY, INSPECTION, STORAGE, AND HANDLING

1.4.1 Delivery

A delivery schedule shall be provided at least 10 calendar days prior to the first day of delivery.

1.4.1.1 Sod

Sod shall be protected during delivery to prevent desiccation, internal heat buildup, or contamination.

1.4.1.2 Delivered Topsoil

Prior to the delivery of any topsoil, its availability shall be verified in paragraph TOPSOIL. A soil test shall be provided for topsoil delivered to the site.

1.4.1.3 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

1.4.1.4 Pesticides

Pesticide material shall be delivered to the site in the original, unopened containers bearing legible labels indicating the EPA registration number and the manufacturer's registered uses.

1.4.2 Inspection

Sod shall be inspected upon arrival at the job site for conformity to species. Sod shall be checked for visible broadleaf weeds, and a visible consistency with no obvious patches of foreign grasses that exceed 2 percent of the canopy. Sod that is heating up, dry, moldy, yellow, irregularly shaped, torn, or of uneven thickness shall be rejected. Other materials shall be inspected for compliance with specified requirements. Open soil amendment containers or wet soil amendments; topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 1-1/2 inch diameter; and topsoil that contains viable plants and plant parts, shall be rejected. Unacceptable materials shall be removed from the job site.

1.4.3 Storage

1.4.3.1 Sod

Sod shall be stored in designated areas and kept in a moist condition by watering with a fine mist, and covered with moist burlap, straw, or other covering. Covering shall allow air to circulate, preventing internal heat from building up. Sod shall be protected from exposure to wind and direct sunlight until installed.

1.4.3.2 Other Material Storage

Materials shall be stored in designated areas. Lime and fertilizer shall be stored in cool, dry locations, away from contaminants. Chemical treatment material shall be stored according to manufacturer's instructions and not with sod operation materials.

1.4.4 Handling

Sod shall not be damaged during handling. Except for bulk deliveries, materials shall not be dropped or dumped from vehicles.

1.4.5 Time Limitation

Time limitation between harvesting and installing sod shall be a maximum 36 hours.

PART 2 PRODUCTS

****

NOTE: Check with local Agriculture Extension Service, State Agricultural Experimental Station, local university, Turfgrass Producers International (TPI), or other reputable source to determine: the proper species to specify; the proper establishment season; sod installation procedures; application rates for the soil amendments; and other installation requirements particular to the project area.

****

2.1 SOD

****
NOTE: Select the grass species required for local growing conditions. Label the sod to be installed in each area. State-certified sod is superior sod grown from certified high quality seed and is more stringently monitored than State-approved sod and therefore, more expensive. Nursery-grown sod is grown on cultivated agricultural land, has reasonable quality, and uniformity of appearance.
****

2.1.1 Sod Classification

[State-certified] [State-approved] [Nursery-grown] sod shall be provided as classified by applicable state laws. Sod section shall be sized to permit rolling and lifting without breaking.

2.1.2 Grass Species

Grass species shall be proportioned as follows:

Botanical Name	Common Name	Mixture Percent
[_____]	[_____]	[_____]

2.1.3 Quality

Sod shall be relatively free of thatch, diseases, nematodes, soil-borne insects, weeds or undesirable plants, stones larger than 1 inch in diameter, woody plant roots, and other materials detrimental to a healthy stand of grass plants. Broadleaf weeds and patches of foreign grasses shall be a maximum 2 percent of the sod section.

2.1.4 Thickness

Sod shall be machine cut to a minimum 1-3/8 inch thickness. Measurement for thickness shall exclude top growth and thatch.

2.1.5 Anchors

Sod anchors shall be as recommended by the sod supplier.

2.1.6 Substitutions

Substitutions will not be allowed without written request and approval from the Contracting Officer.

2.2 TOPSOIL

****
NOTE: Stockpiled topsoil is limited and the areas that will use the soil need to be defined. If suitable topsoil is not available within the limits of the work area, consider the economics of amending

the existing soil in the smooth graded areas with fertilizer and soil amendments versus transporting topsoil to the project site. If amending the existing soil is more economical, establish the requirements for fertilizer and soil amendments.
****

Topsoil shall be as defined in ASTM D 5268. When available, the topsoil shall be the existing surface soil stripped and stockpiled onsite in accordance with Section 02300 EARTHWORK. When additional topsoil is required beyond the available topsoil from stripping operation, topsoil shall be delivered and amended as recommended by the soil test for the sod species specified. Topsoil shall be free from slag, cinders, stones, lumps of soil, sticks, roots, trash, or other material over a maximum 1-1/2 inch diameter. Topsoil shall be free from viable plants and plant parts.

2.3   SOIL AMENDMENTS

****
NOTE: Soil amendments are materials necessary for individual plant health requirements which are incorporated into the native soils during the sodding operation.

Field experience may be used to choose soil amendments to meet the local growing conditions on the project site.
****

Soil amendments shall consist of pH adjuster, fertilizer, organic material, and soil conditioners meeting the following requirements. Vermiculite shall not be used.

2.3.1   pH Adjuster

The pH adjuster shall be an agricultural liming material in accordance with ASTM C 602. These materials may be burnt lime, hydrated lime, ground limestone, or shells. The pH adjuster shall be used to create a favorable soil pH for the plant material specified.

2.3.1.1   Limestone

Limestone material shall contain a minimum calcium carbonate equivalent of 80 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 55 percent shall pass through a No. 60 sieve. To raise soil pH, ground limestone shall be used.

2.3.1.2   Hydrated Lime

Hydrated lime shall contain a minimum calcium carbonate equivalent of 110 percent. Gradation: A minimum 100 percent shall pass through a No. 8 sieve and a minimum 97 percent shall pass through a No. 60 sieve.

2.3.1.3   Burnt Lime

Burnt lime shall contain a minimum calcium carbonate equivalent of 140 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 35 percent shall pass through a No. 60 sieve.

2.3.2   Fertilizer

****

NOTE: Phosphorous is the chemical most responsible for vigorous root growth. Recommended slow release fertilizers should provide a 3-4-1 nutrient ratio; For example 18-24-6.

****

[It shall be as recommended by the soil test] [The nutrients ratio shall be [_____] percent nitrogen, [_____] percent phosphorus, and [_____] percent potassium]. Fertilizer shall be controlled release commercial grade, free flowing, uniform in composition, and consist of a nitrogen-phosphorus-potassium ratio. The fertilizer shall be derived from sulphur coated urea, urea formaldehyde, plastic or polymer coated pills, or isobutylenediurea (IBDU). Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients.

2.3.3   Nitrogen Carrier Fertilizer

[It shall be as recommended by the soil test] [The nutrients ratio shall be [_____] percent nitrogen, [_____] percent phosphorus, and [_____] percent potassium.] Nitrogen carrier fertilizer shall be commercial grade, free flowing, and uniform in composition. The fertilizer may be a liquid nitrogen solution.

2.3.4   Organic Material

Organic material shall consist of either bonemeal, rotted manure, decomposed wood derivatives, recycled compost, or worm castings.

2.3.4.1   Bonemeal

Bonemeal shall be finely ground, steamed bone product containing from 2 to 4 percent nitrogen and 16 to 40 percent phosphoric acid.

2.3.4.2   Rotted Manure

Rotted manure shall be unleached horse, chicken or cattle manure containing a maximum 25 percent by volume straw, sawdust, or other bedding materials. Manure shall contain no chemicals or ingredients harmful to plants. The manure shall be heat treated to kill weed seeds and be free of stones, sticks, and soil.

2.3.4.3   Decomposed Wood Derivatives

Decomposed wood derivatives shall be ground bark, sawdust, yard trimmings, or other wood waste material free of stones, sticks, soil, and toxic substances harmful to plants, fully composted or stabilized with nitrogen.

2.3.4.4   Recycled Compost

Compost shall be a well decomposed, stable, weed free organic matter source. Compost shall be derived from food; agricultural or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. The compost shall possess no objectionable odors and shall not resemble the raw material from which it was derived. The material shall not contain substances toxic to plants.

Gradation: The compost material shall pass through a 3/8 inch screen, possess a pH of 5.5 to 8.0, and have a moisture content between 35-55 percent by weight. The material shall not contain more than 1 percent or less by weight of man-made foreign matter. Compost shall be cleaned of plastic materials larger than 2 inches in length.

2.3.4.5 Worm Castings

Worm castings shall be screened from worms and food source, and shall be commercially packaged.

2.3.5 Soil Conditioner

****

NOTE: Soil conditioners are inorganic materials used to alter the chemical or physical characteristics of the soil.

****

Soil conditioner shall be sand, super absorbent polymers, calcined clay, or gypsum for use singly or in combination to meet the requirements for topsoil.

2.3.5.1 Sand

Sand shall be clean and free of toxic materials. Gradation: A minimum 95 percent by weight shall pass a No. 10 sieve and a minimum 10 percent by weight shall pass a No. 16 sieve. Greensand shall be balanced with the inclusion of trace minerals and nutrients.

2.3.5.2 Super Absorbent Polymers

To improve water retention in soils, super absorbent polymers shall be sized and applied according to the manufacturer's recommendations. Polymers shall be added as a soil amendment and be cross-linked polyacrylamide with an absorption capacity of 250-400 times its weight.

2.3.5.3 Calcined Clay

Calcined clay shall be granular particles produced from montmorillonite clay calcined to minimum temperature of 1200 degrees F. Gradation: A minimum 90 percent passing No. 8 sieve; a minimum 99 percent shall be retained on a No. 60 sieve; and a maximum 2 percent shall pass a No. 100 sieve. Bulk density: A maximum 40 pounds per cubic foot.

2.3.5.4 Gypsum

Gypsum shall be commercially packaged, free flowing, and a minimum 95 percent calcium sulfate by volume.

2.3.5.5 Expanded Shale, Clay, or Slate (ESCS)

Rotary kiln produced ESCS material shall be in conformance with ASTM D 5883.

2.4 WATER

****

NOTE: When water is Government-furnished, locate the source.

****

Water shall be the responsibility of the Contractor unless otherwise noted. Water shall not contain elements toxic to plant life.

2.5 PESTICIDE

Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide or miticide. For the purpose of this specification, a soil fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved.

PART 3 EXECUTION

3.1 INSTALLING SOD TIME AND CONDITIONS

****

NOTE: Specify sodding times as determined by field experience or as recommended by the Department of Agriculture County Extension Service for the species specified and to meet local growing conditions.

****

3.1.1 Sodding Time

Sod shall be installed from [_____] to [_____] for spring establishment; from [_____] to [_____] for summer establishment; and from [_____] to [_____] for fall establishment.

3.1.2 Sodding Conditions

Sodding operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the sodding operations, proposed alternate times shall be submitted for approval.

3.1.3 Equipment Calibration

Immediately prior to the commencement of sodding operations, calibration tests shall be conducted on the equipment to be used. These tests shall confirm that the equipment is operating within the manufacturer's specifications and will meet the specified criteria. The equipment shall be calibrated a minimum of once every day during the operation. Provide calibration test results within one week of testing.

3.1.4 Soil Test

Delivered topsoil, existing soil in smooth graded areas, and stockpiled topsoil shall be tested in accordance with ASTM D 5268 and ASTM D 4972 for determining the particle size, pH, organic matter content, textural class, chemical analysis, soluble salts analysis, and mechanical analysis. Sample collection on site shall be random over the entire site. Sample collection for stockpiled topsoil shall be at different levels in the stockpile. The soil shall be free from debris, noxious weeds, toxic substances, or other materials harmful to plant growth. The test shall determine the quantities and type of soil amendments required to meet local growing conditions for the sod species specified.

3.2 SITE PREPARATION

3.2.1 Finished Grade and Topsoil

****
NOTE: Coordinate the placement of topsoil with Section 02300 EARTHWORK. When stockpiled topsoil is limited, define the areas that will use this soil. It is not necessary to topsoil all areas to be sodded; the smooth graded areas can be amended with soil amendments to meet local growing conditions for the sod specified. This procedure may be more cost effective. Coordinate the topsoil requirements with Sections 02921 SEEDING, 02923 SPRIGGING, and 02930 EXTERIOR PLANTING.
****

Prior to the commencement of the sodding operation, the Contractor shall verify that finished grades are as indicated on drawings; the placing of topsoil, smooth grading, and compaction requirements have been completed in accordance with Section 02300 EARTHWORK.

3.2.2 Application of Soil Amendments

****
NOTE: If more than one pH adjuster, fertilizer or soil conditioner is specified, an application rate will be provided for each material.
****

3.2.2.1 Applying pH Adjuster

[The pH adjuster shall be applied at the rate recommended by the soil test] [The application rate shall be [_____] pounds per 1000 square yards]. The pH adjuster shall be incorporated into the soil to a maximum 4 inch depth or may be incorporated as part of the tillage operation.

3.2.2.2 Applying Fertilizer

[The fertilizer shall be applied at the rate recommended by the soil test] [The application rate shall be [_____] pounds per 1000 square yards]. Fertilizer shall be incorporated into the soil to a maximum 4 inch depth or may be incorporated as part of the tillage or hydroseeding operation.

3.2.2.3 Applying Soil Conditioner

[The soil conditioner shall be as recommended by the soil test] [The application rate shall be [_____] pounds per 1000 square yards]. The soil conditioner shall be spread uniformly over the soil a minimum 1 inch depth and thoroughly incorporated by tillage into the soil to a maximum 4 inches depth.

3.2.2.4 Applying Super Absorbent Polymers

Polymers shall be spread uniformly over the soil as recommended by the manufacturer and thoroughly incorporated by tillage into the soil to a maximum 2 inches deep prior to placement of sod.

3.2.3   Tillage

Soil on slopes up to a maximum 3-horizontal-to-1-vertical shall be tilled to a minimum 4 inches deep. On slopes between 3-horizontal-to-1-vertical and 1-horizontal-to-1 vertical, the soil shall be tilled to a minimum 2 inches deep by scarifying with heavy rakes, or other method. Rototillers shall be used where soil conditions and length of slope permit. On slopes 1-horizontal-to-1 vertical and steeper, no tillage is required. Drainage patterns shall be maintained as indicated on drawings. Areas compacted by construction operations shall be completely pulverized by tillage. Soil used for repair of surface erosion or grade deficiencies shall conform to topsoil requirements. The pH adjuster, fertilizer, and soil conditioner may be applied during this procedure.

3.2.4   Prepared Surface

3.2.4.1   Preparation

The prepared surface shall be a maximum 1 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be rolled and completed with a light raking to remove from the surface debris and stones over a minimum 5/8 inch in any dimension.

3.2.4.2   Protection

Areas within the prepared surface shall be protected from compaction or damage by vehicular or pedestrian traffic and surface erosion.

3.3   INSTALLATION

****

NOTE: Define areas to be installed with sod and areas to be installed with different sod species on the drawings.

****

Prior to installing sod, any previously prepared surface compacted or damaged shall be reworked to meet the requirements of paragraph SITE PREPARATION. Areas shall be sodded as indicated. Adequate soil moisture shall be ensured prior to sodding by spraying water on the area to be sodded and wetting the soil to a maximum 1 inch depth.

3.3.1   Installing Sod

Rows of sod sections shall be placed parallel to and tightly against each other. Joints shall be staggered laterally. The sod sections shall not be stretched or overlapped. All joints shall be butted tight. Voids and air drying of roots shall be prevented. Sod sections shall be laid across the slope on long slopes. Sod sections shall be laid at right angles to the flow of water in ditches. Sod sections shall be anchored on slopes steeper than 3-horizontal-to-1-vertical. Anchoring may be required when surface weight or pressure upon placed sod sections is anticipated to cause lateral movement. Sod anchors shall be placed a minimum 2 feet on center with a minimum 2 anchors per sod section.

3.3.2   Finishing

Displacement of the sod shall be prevented by tamping or rolling the sod in place and knitting the sod to the soil. Air pockets shall be eliminated and a true and even surface shall be provided. Frayed edges shall be trimmed, and holes or missing corners shall be patched with sod.

3.3.3 Rolling

The entire area shall be firmed with a roller not exceeding 90 pounds per foot roller width. Slopes over a maximum 3-horizontal-to-1 vertical shall not be rolled.

3.3.4 Watering Sod

Watering shall be started immediately after completing each day of installing sod. Water shall be applied at least 3 times per week to supplement rainfall, at a rate sufficient to ensure moist soil conditions to a minimum depth of 1 inch. Run-off, puddling, and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or plant material shall be prevented.

3.4 TEMPORARY SEEDING

[The application rate shall be [_____] pounds per 1000 square yards.] When directed during contract delays affecting the sodding operation or when a quick cover is required to prevent surface erosion, the areas designated shall be seeded with annual seed in accordance with Section 02921 SEEDING. When there is no Section 02921 SEEDING provided in the project, an annual seed species and application rate shall be submitted for approval.

3.4.1 Soil Amendments, Tillage and Watering

When soil amendments have not been applied to the area, the quantity of 1/2 of the required soil amendments shall be applied and the area tilled in accordance with paragraph SITE PREPARATION. The area shall be watered in accordance with paragraph Watering Sod as required.

3.4.2 Remaining Soil Amendments

The remaining soil amendments shall be applied in accordance with the paragraph Tillage when the surface is prepared for installing sod.

3.5 QUANTITY CHECK

For materials provided in bags, the empty bags shall be retained for recording the amount used. For materials provided in bulk, the weight certificates shall be retained as a record of the amount used. The amount of the material used shall be compared with the total area covered to determine the rate of application. The quantity of sod used shall be compared against the total area established with sod. Differences between the quantity applied and the quantity specified shall be adjusted as directed.

3.6 APPLICATION OF PESTICIDE

****

NOTE: When a pest is known to be in the soil, identify the pest and the area to be treated.

****

When application of a pesticide becomes necessary to remove a pest or disease, a pesticide treatment plan shall be submitted and coordinated with the installation pest management program.

3.6.1 Technical Representative

The certified installation pest management coordinator shall be the technical representative, and shall be present at all meetings concerning treatment measures for pest or disease control. They may be present during treatment application.

3.6.2 Application

A state certified applicator shall apply required pesticides in accordance with EPA label restrictions and recommendations. Clothing and personal protective equipment shall be used as specified on the pesticide label. A closed system is recommended as it prevents the pesticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying pesticide shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately.

3.7 RESTORATION AND CLEAN UP

3.7.1 Restoration

Existing turf areas, pavements, and facilities that have been damaged from the sodding operation shall be restored to original condition at Contractor's expense.

3.7.2 Clean Up

Excess and waste material shall be removed from the sodded areas and shall be disposed offsite. Adjacent paved areas shall be cleaned.

3.8 PROTECTION OF INSTALLED AREAS

Immediately upon completion of the sodding operation in an area, the area shall be protected against traffic or other use by erecting barricades and providing signage as required, or as directed. Signage shall be in accordance with Section 10430 EXTERIOR SIGNAGE.

3.9 SOD ESTABLISHMENT PERIOD

3.9.1 Commencement

The sod establishment period to obtain a healthy stand of grass plants shall begin on the first day of work under this contract and shall end 3 months after the last day of sodding operation. Written calendar time period shall be furnished for the sod establishment period. When there is more than 1 sod establishment period, the boundaries of the sodded area covered for each period shall be described. The sod establishment period should be coordinated with Sections 02921 SEEDING, 02923 SPRIGGING, and 02930 EXTERIOR PLANTING. The sod establishment period shall be modified for inclement weather, shut down periods, or for separate completion dates of areas.

3.9.2   Satisfactory Stand of Grass Plants

Grass plants shall be evaluated for species and health. A satisfactory stand of grass plants from the sodding operation shall be living sod uniform in color and leaf texture. Bare spots shall be a maximum 2 inch square. Joints between sod pieces shall be tight and free from weeds and other undesirable growth.

3.9.3   Maintenance During Establishment Period

****

NOTE: Check with the State Agricultural Experimental Station, Agricultural Extension Service, or other reputable agency for recommendations on grass heights, and type and application rate for post-fertilization.

****

Maintenance of the sodded areas shall include eradicating weeds, insects and diseases; protecting embankments and ditches from surface erosion; maintaining erosion control materials and mulch; protecting installed areas from traffic; mowing; watering; and post-fertilization.

3.9.3.1   Mowing

Sodded areas shall be mowed to a minimum 3 inch height when the turf is a maximum 4 inch height. Clippings shall be removed when the amount cut prevents sunlight from reaching the ground surface.

3.9.3.2   Post-Fertilization

****

NOTE: This procedure enhances the establishment of the turf. Organic fertilizers are typically applied the first month and again in 5 months. The post-fertilizer should provide a 4-1-2 or 6-1-3 nutrient ratio; for example: 16-4-8 or 24-4-12.

****

[The fertilizer shall be applied as recommended by the soil test] [The application rate shall be [_____] pounds per 1000 square yards]. A maximum 1/2 pound per 1000 square feet of actual available nitrogen shall be provided to the grass plants. The application shall be timed prior to the advent of winter dormancy and shall be made without burning the installed grass plants.

3.9.3.3   Pesticide Treatment

Treatment for disease or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE.

3.9.3.4   Repair

Unsatisfactory stand of grass plants shall be repaired or reinstalled, and eroded areas shall be repaired in accordance with paragraph SITE PREPARATION.

3.9.3.5   Maintenance Record

A record of each site visit shall be furnished which describes the maintenance work performed; areas repaired or reinstalled; and diagnosis for unsatisfactory stand of grass plants.

-- End of Section --

****

DEPARTMENT OF THE ARMY **CEGS-02923 (June 1998)**
U.S. ARMY CORPS OF ENGINEERS **----------------------**
Superseding
CEGS-02935 (June 1990)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

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GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 02923

SPRIGGING
06/98

****
NOTE: This guide specification covers the requirements for installing sprigs. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: Areas to be sprigged must be shown or defined in the project drawings, and if more than 1 method of sprigging is specified, drawings will delineate areas for each method.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AGRICULTURAL MARKETING SERVICE (AMS)

AMS-01	(Aug 95) Federal Seed Act Regulations Part 201

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 602	(1995a) Agricultural Liming Materials
ASTM D 4972	(1995a) pH of Soils
ASTM D 5268	(1992; R 1996) Topsoil Used for Landscaping Purposes
ASTM D 5883	(1996) Standard Guide for Use of Rotary Kiln Produced Expanded Shale, Clay or Slate (ESCS) as a Mineral Amendment in Topsoil Used for Landscaping and Related Purposes

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment; [_____]. Chemical Treatment Material; [_____].

Manufacturer's literature, including physical characteristics, application and installation instructions for equipment and chemical treatment material.

SD-07 Schedules

Equipment; [_____].

A listing of equipment to be used for the sprigging operation.

SD-08 Statements

Delivery; [_____].

Delivery schedule.

Finished Grade and Topsoil; [_____].

Finished grade status.

Topsoil; [_____].

Availability of topsoil from the stripping and stock piling operation.

SD-09 Reports

Equipment Calibration; [_____].

Certification of calibration tests conducted on the equipment used in the sprigging operation.

Soil Test; [_____].

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

SD-13 Certificates

Sprigs; [_____]. Seed; [_____]. Topsoil; [_____]. pH Adjuster; [_____]. Fertilizer; [_____]. Organic Material; [_____]. Soil Conditioner; [_____]. Pesticide; [_____].

Prior to the delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following:

a. Sprigs. Cultivar name, genetic purity and field location.

b. Seed. Classification, botanical name, common name, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, and date tested.

c. Topsoil. Particle size, pH, organic matter content, textural class, soluble salts, chemical and mechanical analyses.

d. pH Adjuster. Calcium carbonate equivalent and sieve analysis.

e. Fertilizer. Chemical analysis and composition percent.

f. Organic Material: Composition and source.

g. Soil Conditioner: Composition and source.

h. Pesticide. EPA registration number and registered uses.

SD-14 Samples

Delivered Topsoil; [_____].

Samples taken from several locations at the source.

Soil Amendments; [_____].

A 10 pound sample.

Temporary Seeding; GA.

Sample of annual seed species and application rate.

SD-18 Records

Quantity Check; [_____].

Bag count or bulk weight measurements of material used compared with area covered to determine the application rate and quantity installed. The quantity of sprigs used shall be compared against the total area installed.

Sprig Establishment Period; [_____].

Calendar time period for the sprig establishment period. When there is more than 1 sprig establishment period, the boundaries of the sprigged area covered for each period shall be described.

Maintenance Record; [_____].

Maintenance work performed, area repaired or reinstalled, diagnosis for unsatisfactory stand of grass plants.

Application of Pesticide; [_____].

Pesticide treatment plan with sequence of treatment work with dates and times. The pesticide trade name, EPA registration number, chemical composition, formulation, concentration of original and diluted material, application rate of active ingredients, method of application, area treated, amount applied; and the name and state license number of the state certified applicator shall be included.

1.3   SOURCE INSPECTION

The sources of sprig material and delivered topsoil shall be subject to inspection.

1.4   DELIVERY, INSPECTION, STORAGE, AND HANDLING

1.4.1   Delivery

A delivery schedule shall be provided at least 10 calendar days prior to the first day of delivery.

1.4.1.1   Sprigs

Sprigs shall be protected during delivery to prevent desiccation, internal heat buildup, or contamination.

1.4.1.2   Delivered Topsoil

Prior to the delivery of any topsoil, its availability shall be verified in paragraph TOPSOIL. A soil test shall be provided for topsoil delivered to the site.

1.4.1.3 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

1.4.1.4 Pesticides

Pesticide material shall be delivered to the site in the original, unopened containers, bearing legible labels indicating the EPA registration number and the manufacturer's registered uses.

1.4.2 Inspection

Sprigs shall be inspected upon arrival at the jobsite for conformity to cultivar and genetic purity. Sprigs shall have attached roots with 2 to 3 nodes and shall be 4 to 6 inches in length, with no adhering soil, weed stems, or roots. Sprigs that have been exposed to heat or excessive drying shall be rejected. Seed shall be inspected upon arrival at the job site for conformity to cultivar and quality. Seed that is wet, moldy, or bears a test date 5 months or older, shall be rejected. Other materials shall be inspected for compliance. The following shall be rejected: open soil amendment containers or wet soil amendments; topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 1-1/2 inch diameter; and topsoil that contains viable plants and plant parts. Unacceptable materials shall be removed from the job site.

1.4.3 Storage

1.4.3.1 Sprigs

Sprigs shall be stored in designated areas and covered with moist burlap, straw, or other covering. Covering shall allow air to circulate preventing internal heat from building up. Sprigs shall be protected from exposure to wind, and direct sunlight until installed.

1.4.3.2 Other Material Storage

Materials shall be stored in designated areas. Seed, lime, and fertilizer shall be stored in cool, dry locations away from contaminants. Chemical treatment material shall be stored according to manufacturer's instructions and not with plant material or other materials.

1.4.4 Handling

Sprigs shall not be damaged during handling. Except for bulk deliveries, materials shall not be dropped or dumped from vehicles.

1.4.5 Time Limitation

Time limitation between harvesting and installing sprigs shall be a maximum 24 hours. Hydroseeding time limitation for holding seed in the slurry shall be a maximum 24 hours.

PART 2 PRODUCTS

****
NOTE: Check with local Agriculture Extension Service, State Agricultural Experimental Station, local university, Turfgrass Producers International (TPI) or other reputable source to determine the proper cultivar that should be specified; the proper establishment season; sprig installation procedures; application rates for the soil amendments; and other installation requirements particular to the project area.
****

2.1 SPRIGS

2.1.1 Sprig Cultivar

The cultivar of [_____] shall be healthy living stems, stolons, or rhizomes. They shall have attached roots from 4 to 6 inches long that include 2 to 3 nodes.

2.1.2 Quality

Sprigs shall be grown under climatic conditions similar to those in the locality of the project. Sprigs shall have no adhering soil, weed stems, or roots. Sprigs shall be obtained from heavy and dense sod, and shall be free from material detrimental to a healthy stand of grass plants. Sprigs that have been exposed to heat or excessive drying shall be rejected.

2.2 SEED

****
NOTE: When applying seed over sprigs as a specified method of establishing sprigs, select the annual seed species to be installed. State-certified seed is more stringently monitored than State-approved seed; and therefore, more expensive.
****

2.2.1 Seed Classification

[State-certified] [State-approved] seed of the latest season's crop shall be provided in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with AMS-01 and applicable state seed laws.

2.2.2 Temporary Seed Species

Botanical Name	Common Name	Percent Pure Live Seed
[_____]	[_____]	[_____]

Weed seed shall be a maximum 1 percent by weight of the total mixture.

2.3 SUBSTITUTIONS

Substitutions will not be allowed without written request and approval from the Contracting Officer.

2.4 TOPSOIL

****
NOTE: Stockpiled topsoil is limited and the areas need to be defined that will use the soil. If suitable topsoil is not available within the limits of the work area, consider the economics of amending the existing soil in the smooth graded areas with fertilizer and soil amendments versus transporting topsoil to the project site. If amending the existing soil is more economical, establish the requirements for fertilizer and soil amendments.
****

Topsoil shall be as defined in ASTM D 5268. When available, the topsoil shall be the existing surface soil, stripped and stockpiled onsite in accordance with Section 02300 EARTHWORK. When additional topsoil is required beyond the available topsoil from stripping operation, topsoil shall be delivered and amended as recommended by the soil test for the sprig plants specified. Topsoil shall be free from slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 1-1/2 inch diameter. Topsoil shall be free from viable plants and plant parts.

2.5 SOIL AMENDMENTS

****
NOTE: Soil amendments are materials necessary for individual plant health requirements, which are incorporated into the native soils during the sprigging operation.

Field experience may be used to choose soil amendments to meet the local growing conditions on the project site.
****

Soil amendments shall consist of pH adjuster, fertilizer, organic material, and soil conditioners meeting the following requirements. Vermiculite shall not be used.

2.5.1 pH Adjuster

The pH adjuster shall be an agricultural liming material in accordance with ASTM C 602. These materials may be burnt lime, hydrated lime, ground limestone, or shells. The pH adjuster shall be used to create a favorable soil pH for the plant material specified.

2.5.1.1 Limestone

Limestone material shall contain a minimum calcium carbonate equivalent of 80 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 55 percent shall pass through a No. 60 sieve. To raise soil pH, ground limestone shall be used.

2.5.1.2   Hydrated Lime

Hydrated lime shall contain a minimum calcium carbonate equivalent of 110 percent. Gradation: A minimum 100 percent shall pass through a No. 8 sieve and a minimum 97 percent shall pass through a No. 60 sieve.

2.5.1.3   Burnt Lime

Burnt lime shall contain a minimum calcium carbonate equivalent of 140 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 35 percent shall pass through a No. 60 sieve.

2.5.2   Fertilizer

****

NOTE: Phosphorous is the chemical most responsible for vigorous root growth. Recommended slow release fertilizers should provide a 3-4-1 nutrient ratio; For example 18-24-6.

****

[It shall be as recommended by the soil test] [The nutrients ratio shall be [_____] percent nitrogen, [_____] percent phosphorus, and [_____] percent potassium]. Fertilizer shall be controlled release commercial grade, free flowing, uniform in composition, and consist of a nitrogen-phosphorus-potassium ratio. The fertilizer shall be derived from sulphur coated urea, urea formaldehyde, plastic or polymer coated pills, or isobutylenediurea (IBDU). Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients.

2.5.3   Nitrogen Carrier Fertilizer

[It shall be as recommended by the soil test] [The nutrients ratio shall be [_____] percent nitrogen, [_____] percent phosphorus, and [_____] percent potassium.] Nitrogen carrier fertilizer shall be commercial grade, free flowing, and uniform in composition. The fertilizer may be a liquid nitrogen solution.

2.5.4   Organic Material

Organic material shall consist of either bonemeal, rotted manure, decomposed wood derivatives, recycled compost, or worm castings.

2.5.4.1   Bonemeal

Bonemeal shall be finely ground, steamed bone product, containing from 2 to 4 percent nitrogen and 16 to 40 percent phosphoric acid.

2.5.4.2   Rotted Manure

Rotted manure shall be unleached horse, chicken, or cattle manure containing a maximum 25 percent by volume of straw, sawdust, or other bedding materials. It shall contain no chemicals or ingredients harmful to plants. The manure shall be heat treated to kill weed seeds and be free of stones, sticks, and soil.

2.5.4.3   Decomposed Wood Derivatives

Decomposed wood derivatives shall be ground bark, sawdust, yard trimmings, or other wood waste material free of stones, sticks, soil, and toxic substances harmful to plants, fully composted, or stabilized with nitrogen.

2.5.4.4 Recycled Compost

Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from food, agricultural, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. The compost shall possess no objectionable odors and shall not resemble the raw material from which it was derived. The material shall not contain substances toxic to plants. Gradation: The compost material shall pass through a 3/8 inch screen, possess a pH of 5.5 to 8.0, and have a moisture content between 35-55 percent by weight. The material shall not contain more than 1 percent or less by weight of man-made foreign matter. Compost shall be cleaned of plastic materials larger than 2 inches in length.

2.5.4.5 Worm Castings

Worm castings shall be screened from worms and food source, and shall be commercially packaged.

2.5.5 Soil Conditioner

****

NOTE: Soil conditioners are inorganic materials used to alter the chemical or physical characteristics of the soil.

****

Soil conditioner shall be sand, super absorbent polymers, calcined clay, or gypsum for use singly or in combination to meet the requirements for topsoil.

2.5.5.1 Sand

Sand shall be clean and free of toxic materials. Gradation: A minimum 95 percent by weight shall pass a No. 10 sieve and a minimum 10 percent by weight shall pass a No. 16 sieve. Greensand shall be balanced with the inclusion of trace minerals and nutrients.

2.5.5.2 Super Absorbent Polymers

To improve water retention in soils, super absorbent polymers shall be sized and applied according to the manufacturer's recommendations. Polymers shall be added as a soil amendment and be cross-linked polyacrylamide with an absorption capacity of 250-400 times its weight. Polymers shall also be added to the seed, and be a starch grafted polyacrylonitrite with graphite added as a tacky sticker. Polymers shall have an absorption capacity of 100 plus times its weight.

2.5.5.3 Calcined Clay

Calcined clay shall be granular particles produced from montmorillonite clay calcined to minimum temperature of 1200 degrees F. Gradation: A minimum 90 percent passing No. 8 sieve; a minimum 99 percent shall be retained on a No. 60 sieve; and a maximum 2 percent shall pass a No. 100 sieve. Bulk density: A maximum 40 pounds per cubic foot.

2.5.5.4 Gypsum

Gypsum shall be commercially packaged, free flowing, and a minimum 95 percent calcium sulfate by volume.

2.5.5.5 Expanded Shale, Clay, or Slate (ESCS)

Rotary kiln produced ESCS material shall be in conformance with ASTM D 5883.

2.6 MULCH

Mulch shall be free from weeds, mold, and other deleterious materials. Mulch materials shall be native to the region.

2.6.1 Straw

Straw shall be stalks from oats, wheat, rye, barley, or rice furnished in air-dry condition, and with a consistency for placing with commercial mulch-blowing equipment.

2.6.2 Hay

Hay shall be native hay, sudan-grass hay, broomsedge hay, or other herbaceous mowings furnished in an air-dry condition, suitable for placing with commercial mulch-blowing equipment.

2.6.3 Wood Cellulose Fiber

Wood cellulose fiber shall not contain any growth or germination-inhibiting factors, and shall be dyed an appropriate color to facilitate placement during application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 4.5 to 6.0.

2.6.4 Paper Fiber

Paper fiber mulch shall be recycled news print that is shredded for the purpose of mulching seed.

2.7 WATER

****

NOTE: When water is Government-furnished, locate the source.

****

Unless otherwise noted, water shall be the responsibility of the Contractor. Water shall not contain elements toxic to plant life.

2.8 PESTICIDE

Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide or miticide. For the purpose of this specification, soil fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved.

PART 3 EXECUTION

3.1 INSTALLING SPRIGS TIME AND CONDITIONS

****

NOTE: Specify sprigging times as determined by field experience or as recommended by the Department of Agriculture County Extension Service for the cultivar specified and to meet local growing conditions.

****

3.1.1 Sprigging Time

Sprigs shall be installed from [_____] to [_____] for spring establishment; from [_____] to [_____] for summer establishment; and from [_____] to [_____] for fall establishment.

3.1.2 Sprigging Conditions

Sprigging operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the sprigging operations, proposed alternate times shall be submitted for approval.

3.1.3 Equipment Calibration

Immediately prior to the commencement of sprigging operations, calibration tests shall be conducted on the equipment to be used. These tests shall confirm that the equipment is operating within the manufacturer's specifications and will meet the specified criteria. The equipment shall be calibrated a minimum of once every day during the operation. Provide the calibration test results within 1 week of testing.

3.1.4 Soil Test

Delivered topsoil, existing soil in smooth graded areas, and stockpiled topsoil shall be tested in accordance with ASTM D 5268 and ASTM D 4972 for determining the particle size, pH, organic matter content, textural class, chemical analysis, soluble salts analysis, and mechanical analysis. Sample collection onsite shall be random over the entire site. Sample collection for stockpiled topsoil shall be at different levels in the stockpile. The soil shall be free from debris, noxious weeds, toxic substances, or other materials harmful to plant growth. The test shall determine the quantities and type of soil amendments required to meet local growing conditions for the sprig cultivar specified.

3.2 SITE PREPARATION

3.2.1 Finished Grade and Topsoil

****

NOTE: Coordinate the placement of topsoil with Section 02300 EARTHWORK. When stockpiled topsoil is limited, define the areas that will use this soil. It is not necessary to topsoil all areas to be sprigged; the smooth graded areas can be amended with soil amendments to meet local growing conditions for the sprigs specified. This procedure may be more cost effective. Coordinate the topsoil

requirements with Sections 02921 SEEDING, 02922 SODDING, and 02930 EXTERIOR PLANTING.
****

Prior to the commencement of sprigging operation, the Contractor shall verify that finished grades are as indicated on drawings, and the placing of topsoil, smooth grading, and compaction requirements have been completed in accordance with Section 02300 EARTHWORK.

3.2.2 Application of Soil Amendments

****
NOTE: If more than one pH adjuster, fertilizer, or soil conditioner is specified, an application rate will be provided for each material.
****

3.2.2.1 Applying pH Adjuster

[The pH adjuster shall be applied at the rate recommended by the soil test] [The application rate shall be [_____] pounds per 1000 square yards]. The pH adjuster shall be incorporated into the soil to a maximum 4 inch depth or may be incorporated as part of the tillage operation.

3.2.2.2 Applying Fertilizer

[The fertilizer shall be applied at the rate recommended by the soil test] [The application rate shall be [_____] pounds per 1000 square yards]. Fertilizer shall be incorporated into the soil to a maximum 4 inch depth or may be incorporated as part of the tillage or hydroseeding operation.

3.2.2.3 Applying Soil Conditioner

[The soil conditioner shall be as recommended by the soil test] [The application rate shall be [_____] pounds per 1000 square yards]. The soil conditioner shall be spread uniformly over the soil a minimum 1 inch depth and thoroughly incorporated by tillage into the soil to a maximum 4 inches depth.

3.2.2.4 Applying Super Absorbent Polymers

Polymers shall be applied at the rate recommended by the manufacturer and incorporated into the soil to a maximum 4 inch depth as part of the tillage operation.

3.2.3 Tillage

Soil on slopes up to a maximum 3-horizontal-to-1-vertical shall be tilled to a minimum depth of 4 inches. On slopes between 3-horizontal-to-1-vertical and 1-horizontal-to-1 vertical, the soil shall be tilled to a minimum depth of 2 inches by scarifying with heavy rakes, or other method. Rototillers shall be used where soil conditions and length of slope permit. On slopes 1-horizontal-to-1 vertical and steeper, no tillage is required. Drainage patterns shall be maintained as indicated on drawings. Areas compacted by construction operations shall be completely pulverized by tillage. Soil used for repair of surface erosion or grade deficiencies shall conform to topsoil requirements. The pH adjuster, fertilizer and soil conditioner may be applied during this procedure.

3.2.4   Prepared Surface

3.2.4.1   Preparation

The prepared surface shall be a maximum 1 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be rolled and completed with a light raking to remove debris.

3.2.4.2   Lawn Area Debris

Debris and stones over a minimum 5/8 inch in any dimension shall be removed from the surface.

3.2.4.3   Field Area Debris

****
NOTE: Provide for a prepared surface of areas not requiring fine raking to remove debris and stones a minimum 16 mm (5/8 inch). This procedure may be more cost effective for areas not requiring a lawn finish.
****

Debris and stones over a minimum 3 inches in any dimension shall be removed from the surface.

3.2.4.4   Protection

Areas with the prepared surface shall be protected from compaction and damage by vehicular or pedestrian traffic and surface erosion.

3.3   INSTALLATION

****
NOTE: Allow the Contractor sprig installation options when installing areas larger than 1 acre. Define lawn areas and field areas on the drawings.
****

Prior to installing sprigs, any previously prepared surface compacted or damaged shall be reworked to meet the requirements of paragraph SITE PREPARATION. Areas shall be sprigged as indicated.

3.3.1   Installing Sprigs

The sprigging method shall be [Broadcast Sprigging] [Hydroplanting] [Row Sprigging] [applying seed-over-sprigs]. Sprigging procedure shall ensure even coverage.

3.3.1.1   Broadcast Sprigging

Sprigs shall be broadcast uniformly by hand, with mechanical equipment, or other approved method. Sprigs shall be planted to provide a minimum number of 25 viable sprigs per square yard. The distance between individual sprigs shall be a maximum 12 inch space. Sprigs shall be forced into the soil to a minimum 1 inch depth by disk-rolling, pressing with steel matting, or other approved method.

3.3.1.2 Hydroplanting

Sprigs shall be mixed with water and uniformly applied under pressure over the entire area. Sprigs shall be covered by distributing a topdressing uniformly and evenly to a minimum 1 inch depth. Topdressing shall conform to the paragraph TOPSOIL.

3.3.1.3 Row Sprigging

Sprigs shall be planted in rows spaced a maximum of 12 inches apart and to a minimum 1 inch depth, with mechanical sprig planter or other methods. Sprigs shall be placed in the rows a maximum 6 inch distance apart.

3.3.2 Mulching

3.3.2.1 Hay or Straw Mulch

Hay or straw mulch shall be spread uniformly at the rate of 2 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader, or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch shall not be bunched or clumped. Sunlight shall not be completely excluded from penetrating to the ground surface. All areas installed with seed shall be mulched on the same day as the seeding. Mulch shall be anchored immediately following spreading.

3.3.2.2 Mechanical Anchor

Mechanical anchor shall be a V-type-wheel land packer; a scalloped-disk land packer designed to force mulch into the soil surface; or other suitable equipment.

3.3.2.3 Wood Cellulose Fiber, Paper Fiber and Recycled Paper

Wood cellulose fiber, paper fiber, or recycled paper shall be applied as part of the hydroseeding operation. The mulch shall be mixed and applied in accordance with the manufacturer's recommendations.

3.3.3 Applying Seed Over Sprigs

Seed shall be applied using either [broadcast] [or] [hydroseeding] equipment and methods. Seeding procedure shall ensure even coverage. Gravity feed applicators, which drop seed directly from a hopper onto the prepared soil, shall not be used.

3.3.3.1 Broadcast Seeding

Seed shall be uniformly broadcast at the rate of [_____] pounds per 1000 square feet using broadcast seeders. Half the total rate of seed application shall be broadcast in 1 direction, with the remainder of the seed rate broadcast at 90 degrees from the first direction. Seed shall be covered to a minimum 1/4 inch depth by disk harrow, steel mat drag, cultipacker, or other approved device. Seed shall be broadcast and covered prior to sprigging operation.

3.3.3.2 Hydroseeding

Seed shall be mixed to ensure broadcast at the rate of [_____] pounds per 1000 square feet. Seed and fertilizer shall be added to water and thoroughly mixed at the rates specified. The maximum time period for the seed to be held in the slurry shall be 24 hours. [Wood cellulose fiber mulch and tackifier shall be added at the rates recommended by the manufacturer after the seed, fertilizer, and water have been thoroughly mixed to produce a homogeneous slurry.] Slurry shall be uniformly applied under pressure over the entire area. The hydroseeded area shall not be rolled.

3.3.4 Rolling

The entire area shall be firmed with a roller not exceeding 90 pounds per foot roller width. Slopes over a maximum 3-horizontal-to-1 vertical shall not be rolled.

3.3.5 Finishing

A minimum 25 percent of the installed sprigs shall extend above the ground surface upon completion of the sprigging operation.

3.3.6 Watering Sprigs

Watering shall be started immediately after completing each day of sprigging. Water shall be applied at a rate sufficient to ensure moist soil conditions to a minimum 1 inch depth. Run-off, puddling, and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or plant material shall be prevented.

3.4 TEMPORARY SEEDING

[The application rate shall be [_____] pounds per 1000 square yards.] When directed during contract delays affecting the sprigging operation or when a quick cover is required to prevent surface erosion, the areas designated shall be seeded in accordance with temporary seed species listed under paragraph SEED.

3.4.1 Soil Amendments

When no soil amendments have been applied to the area, the quantity of 1/2 of the required soil amendments shall be applied and the area tilled in accordance with paragraph SITE PREPARATION. The area shall be watered in accordance with paragraph Watering Sprigs as required.

3.4.2 Remaining Soil Amendments

The remaining soil amendments shall be applied in accordance with the paragraph Tillage when the surface is prepared for installing sprigs.

3.5 QUANTITY CHECK

For materials provided in bags, the empty bags shall be retained for recording the amount used. For materials provided in bulk, the weight certificates shall be retained as a record of the amount used. The amount of the material used shall be compared with the total area covered to determine the rate of application used. The quantity of sprigs used shall be compared against the total area established with sprigs. Differences between the quantity applied and the quantity specified shall be adjusted as directed.

3.6 APPLICATION OF PESTICIDE

****

NOTE: When a pest is known to be in the soil, identify the pest and the area to be treated.

****

When application of a pesticide becomes necessary to remove a pest or disease, a pesticide treatment plan shall be submitted and coordinated with the installation pest management program.

3.6.1 Technical Representative

The certified installation pest management coordinator shall be the technical representative, and shall be present at all meetings concerning treatment measures for pest or disease control. They may be present during treatment application.

3.6.2 Application

A state certified applicator shall apply required pesticides in accordance with EPA label restrictions and recommendations. Clothing and personal protective equipment shall be used as specified on the pesticide label. A closed system is recommended as it prevents the pesticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying pesticide shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately.

3.7 RESTORATION AND CLEAN UP

3.7.1 Restoration

Existing turf areas, pavements, and facilities that have been damaged from the sprigging operation shall be restored to original condition at Contractor's expense.

3.7.2 Clean Up

Excess and waste material shall be removed from the sprigged areas and shall be disposed offsite. Adjacent paved areas shall be cleaned.

3.8 PROTECTION OF INSTALLED AREAS

Immediately upon completion of the sprigging operation in an area, the area shall be protected against traffic or other use by erecting barricades and providing signage as required, or as directed. Signage shall be in accordance with Section 10430 EXTERIOR SIGNAGE.

3.9 SPRIG ESTABLISHMENT PERIOD

3.9.1 Commencement

The sprig establishment period to obtain a healthy stand of grass plants shall begin on the first day of work under this contract and shall end 3 months after the last day of sprigging operations. Written calendar time period shall be furnished for the sprig establishment period. When there is more than 1 sprig establishment period, the boundaries of the sprigged area covered for each period shall be described. The sprig establishment period shall be coordinated with Sections 02921 SEEDING, 02922 SODDING, and 02930 EXTERIOR PLANTS. The sprig establishment period shall be modified for inclement weather, shut down periods, or for separate completion dates of areas.

3.9.2 Satisfactory Stand of Grass Plants

Grass plants shall be evaluated for cultivar and health when grass plants are a minimum 1 inch high. A satisfactory stand of grass plants from the sprigging operation shall be a minimum 6 grass plants per square foot. When annual seed is applied over the sprigs, the annual grass plants shall not be counted. Bare spots shall be a maximum 9 inch square. The total bare spots shall be a maximum 2 percent of the total sprigged area.

3.9.3 Maintenance During Establishment Period

****

NOTE: Check with the State Agricultural Experimental Station, Agricultural Extension Service or other reputable agency for area specific recommendations on grass heights, and type and application rate for post-fertilizer.

****

Maintenance of the sprigged areas shall include eradicating weeds, insects, and diseases; protecting embankments and ditches from surface erosion; maintaining erosion control materials and mulch; protecting installed areas from traffic; mowing; watering; and post-fertilization.

3.9.3.1 Mowing

a. Lawn Areas: Lawn areas shall be mowed to a minimum 3 inch height when the sprigs are a maximum 4 inches high. Clippings shall be removed when the amount cut prevents sunlight from reaching the ground surface.

b. Field Areas: Field areas shall be mowed once during the season to a minimum 3 inch height. Clippings shall be removed when the amount cut prevents sunlight from reaching the ground surface.

3.9.3.2 Post-Fertilization

****

NOTE: This procedure enhances the establishment of the turf. Organic fertilizers are typically applied the first month and again in 5 months. The post-fertilizer should provide a 4-1-2 or 6-1-3 nutrient ratio; for example: 16-4-8 or 24-4-12.

****

[The fertilizer shall be applied as recommended by the soil test] [The application rate shall be [_____] pounds per 1000 square yards]. A maximum 1/2 pound per 1000 square feet of actual available nitrogen shall be provided to the grass plants. The application shall be timed prior to the advent of winter dormancy and shall be made without burning the installed grass plants.

3.9.3.3 Pesticide Treatment

Treatment for disease or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE.

3.9.3.4 Repair

Unsatisfactory stand of grass plants shall be repaired or reinstalled, and eroded areas shall be repaired in accordance with paragraph SITE PREPARATION.

3.9.3.5 Maintenance Record

A record of each site visit shall be furnished describing the maintenance work performed; areas repaired or reinstalled; and diagnosis for unsatisfactory stand of grass plants.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02930 (June 1998)**
U.S. ARMY CORPS OF ENGINEERS **----------------------**
Superseding
CEGS-02950 (June 1990)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02930

EXTERIOR PLANTING
06/98

****

NOTE: This guide specification covers the requirements for installing trees, shrubs, ground cover, and vines. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

****

NOTE: Areas to receive plant materials must be shown or defined in the project drawings. The drawings will delineate individual plant material, mass plantings, and plant bed locations.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide

specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NURSERY AND LANDSCAPE ASSOCIATION (ANLA)

ANLA ANSI/ANLA Z60.1	(1996) Nursery Stock

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A300	(1995) Tree Care Operations - Trees, Shrubs and other Woody Plant Maintenance

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 602	(1995a) Agricultural Liming Materials
ASTM D 4972	(1995a) pH of Soils
ASTM D 5034	(1995) Breaking Strength and Elongation of Textile Fabrics (Grab Test)
ASTM D 5035	(1995) Breaking Strength and Elongation of Textile Fabrics (Grab Test)
ASTM D 5268	(1992; R1996) Topsoil Used for Landscaping Purposes
ASTM D 5883	(1996) Standard Guide for Use of Rotary Kiln Produced Expanded Shale, Clay or Slate (ESCS) as a Mineral Amendment in Topsoil Used for Landscaping and Related Purposes

1.2 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" where the submittal requires Government approval or "FIO" where the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Geotextile; [_____]. Chemical Treatment Material; [_____].

Manufacturer's literature including physical characteristics, application and installation instructions for geotextile and chemical treatment material.

SD-04 Drawings

Shop Drawings; [_____].

Scale drawings defining areas to receive plant materials.

SD-07 Schedules

Equipment; [_____].

A listing of equipment to be used for the planting operation.

SD-08 Statements

Delivery; [_____].

Delivery schedule.

Finished Grade, Topsoil and Underground Utilities; [_____].

Finished grade status; location of underground utilities and facilities; and availability of topsoil from the stripping and stock piling operation.

SD-09 Reports

Soil Test; [_____]. Percolation Test; [_____].

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

SD-13 Certificates

Plant Material; [_____]. Topsoil; [_____]. pH Adjuster; [_____]. Fertilizer; [_____]. Organic Material; [_____]. Soil Conditioner; [_____]. Organic Mulch; [_____]. Mycorrhizal Fungi Inoculum; [_____]. Pesticide; [_____].

Prior to delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following.

a. Plant Material: Classification, botanical name, common name, size, quantity by species, and location where grown.

b. Topsoil: Particle size, pH, organic matter content, textural class, soluble salts, chemical and mechanical analyses.

c. pH Adjuster: Sieve analysis and calcium carbonate equivalent.

d. Fertilizer: Chemical analysis and composition percent.

e. Organic Material: Composition and source.

f. Soil Conditioner: Composition and source.

g. Organic Mulch: Composition, source, and treatment against fungi growth.

h. Mycorrhizal Fungi Inoculum: Plant material treated.

i. Pesticide. EPA registration number and registered uses.

SD-14 Samples

Delivered Topsoil; [_____].

Samples taken from several locations at the source.

Soil Amendments; [_____].

A 10 pound sample.

Mulch; [_____].

A 10 pound sample.

Geotextile; [_____].

A 6 inch square sample.

SD-18 Records

Plant Establishment Period; [_____].

Calendar time period for the plant establishment period. When there is more than one establishment period, the boundaries of the planted areas covered for each period shall be described.

Maintenance Record; [_____].

Maintenance work performed, quantity of plant losses, and replacements; and diagnosis of unhealthy plant material.

Application of Pesticide; [_____].

Pesticide treatment plan with sequence of treatment work with dates and times. The pesticide trade name, EPA registration number, chemical composition, formulation, concentration of original and diluted material, application rate of active ingredients, method of application, area treated, amount applied; and the name and state license number of the state certified applicator shall be included.

SD-19 Operation and Maintenance Manuals

Maintenance Instructions; [_____].

Instruction for year-round care of installed plant material.

1.3 SOURCE INSPECTIONS

The nursery or source of plant material and the source of delivered topsoil shall be subject to inspection.

1.4 DELIVERY, INSPECTION, STORAGE, AND HANDLING

1.4.1 Delivery

A delivery schedule shall be provided at least 10 calendar days prior to the first day of delivery.

1.4.1.1 Plant Material Identification

Plant material shall be identified with attached, durable, waterproof labels and weather-resistant ink, stating the correct botanical plant name and size.

1.4.1.2 Protection During Delivery

Plant material shall be protected during delivery to prevent desiccation and damage to the branches, trunk, root system, or earth ball. Branches shall be protected by tying-in. Exposed branches shall be covered during transport.

1.4.1.3 Delivered Topsoil

Prior to the delivery of any topsoil, the availability of topsoil shall be verified in paragraph TOPSOIL. A soil test shall be provided for delivered topsoil.

1.4.1.4 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

1.4.1.5 Pesticide Material

Pesticide material shall be delivered to the site in the original, unopened containers bearing legible labels indicating the Environmental Protection Agency (EPA) registration number and the manufacturer's registered uses.

1.4.2 Inspection

Plant material shall be well shaped, vigorous and healthy with a healthy, well branched root system, free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement or abrasion. Plant material shall be checked for unauthorized substitution and to establish nursery grown status. Plant material showing desiccation, abrasion, sun-scald injury, disfigurement, or unauthorized substitution shall be rejected. The plant material shall exhibit typical form of branch to height ratio; and meet the caliper and height measurements specified. Plant material that measures less than specified, or has been poled, topped off or headed back, shall be rejected. Container-grown plant material shall show new fibrous roots and the root mass shall contain its shape when removed from the container. Plant material with broken or cracked balls; or broken containers shall be rejected. Bare-root plant material that is not dormant or is showing roots were pulled from the ground shall be rejected. Other materials shall be inspected for compliance with paragraph PRODUCTS. Open soil amendment containers or wet soil amendments shall be rejected. Topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, trash or other material larger than 1-1/2 inch diameter shall be rejected. Topsoil that contains viable plant material and plant parts shall be rejected. Unacceptable material shall be removed from the job site.

1.4.3 Storage

1.4.3.1 Plant Material Storage

Plant material not installed on the day of arrival at the site shall be stored and protected in designated areas. Plant material shall not be stored longer than 30 days. Plant material shall be protected from direct exposure to wind and sun. Bare-root plant material shall be heeled-in. All plant material shall be kept in a moist condition by watering with a fine mist spray until installed.

1.4.3.2 Other Material Storage

Storage of other material shall be in designated areas. Soil amendments shall be stored in dry locations and away from contaminants. Chemical treatment material shall be stored according to manufacturer's instructions and not with planting operation material.

1.4.4 Handling

Plant material shall not be injured in handling. Cracking or breaking the earth ball of balled and burlapped plant material shall be avoided. Plant material shall not be handled by the trunk or stems. Materials shall not be dropped from vehicles.

1.4.5 Time Limitation

Except for container-grown plant material, the time limitation from digging to installing plant material shall be a maximum 90 days. The time limitation between installing the plant material and placing the mulch shall be a maximum 24 hours.

1.5 WARRANTY

Furnished plant material shall have a warranty for plant growth to be in a vigorous growing condition for a minimum 12 month period. A minimum 12 month calendar time period for the warranty of plant growth shall be provided regardless of the contract time period. When plant material is determined to be unhealthy in accordance with paragraph PLANT ESTABLISHMENT PERIOD, it shall be replaced once under this warranty.

PART 2 PRODUCTS

2.1 PLANT MATERIAL

****

NOTE: Check with local Agriculture Extension Service, State Agricultural Experimental Station, local university, or other reputable source to determine the proper species to specify; the proper planting season; application rates for the soil amendments; percolation of the project site, and

other plant material requirements particular to the project area.
****

2.1.1 Plant Material Classification

****
NOTE: Specify collected plant material when they are required. Plant material collected from native stands or established plantings must be designated as such. Plant material growing in their native stand without the roots being pruned one year prior to shipping will sustain much more shock when transplanted than the nursery grown plant material. Collected plant material have not adapted to changing microclimatic conditions of sun exposure or soil conditions.
****

The plant material shall be nursery grown stock conforming to ANLA ANSI/ANLA Z60.1 and shall be the species specified.

2.1.2 Plant Schedule

****
NOTE: The minimum information that a plant schedule provides shall be the botanical name, common name, classification, caliper, height, method of handling or shipping, and special characteristics.
****

The plant schedule shall provide botanical names as included in one or more of the publications listed under "Nomenclature" in ANLA ANSI/ANLA Z60.1.

2.1.3 Substitutions

Substitutions will not be permitted without written request and approval from the Contracting Officer.

2.1.4 Quality

****
NOTE: When collected plant material or plantation grown plant material are specified, the quality of the plant material will be lower and must be stated accordingly. Collected plant material may have irregular shape and sparse branching.
****

Well shaped, well grown, vigorous plant material having healthy and well branched root systems in accordance with ANLA ANSI/ANLA Z60.1 shall be provided. Plant material shall be provided free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement and abrasion. Plant material shall be free of shock or damage to branches, trunk, or root systems, which may occur from the digging and preparation for shipment, method of shipment, or shipment. Plant quality is determined by the growing conditions; method of shipment to maintain health of the root system; and growth of the trunk and crown as follows.

2.1.5 Growing Conditions

Plant material shall be native to or well-suited to the growing conditions of the project site. Plant material shall be grown under climatic conditions similar to those at the project site.

2.1.6 Method of Shipment to Maintain Health of Root System

2.1.6.1 Balled and Burlapped (BB) Plant Material

Ball size and ratio shall be in accordance with ANLA ANSI/ANLA Z60.1. The ball shall be of a diameter and depth to encompass enough fibrous and feeding root system necessary for the full recovery of the plant. The plant stem or trunk shall be centered in the ball. All roots shall be clean cut at the ball surface. Roots shall not be pulled from the ground. Before shipment the root ball shall be dipped in gels containing mycorrhizal fungi inoculum. The root ball shall be completely wrapped with burlap or other suitable material and securely laced with biodegradable twine.

2.1.6.2 Balled and Potted (Pot) Plant Material

Ball size and ratio shall be in accordance with ANLA ANSI/ANLA Z60.1. The ball shall be of a diameter and depth to encompass enough fibrous and feeding root system necessary for the full recovery of the plant. Removal shall be done by hand digging or mechanical devices. The plant stem or trunk shall be centered in the ball. All roots shall be clean cut at the ball surface. Roots shall not be pulled from the ground. Before shipment the root ball shall be dipped in gels containing mycorrhizal fungi inoculum. Container shall be used to retain the ball unbroken. Container shall be rigid to hold ball shape and protect root mass during shipping.

2.1.6.3 Balled and Platform (BP) Plant Material

Ball size and ratio shall be in accordance with ANLA ANSI/ANLA Z60.1. Plants shall be prepared as balled and burlapped plant material and securely fastened to wood platform for shipping.

2.1.6.4 Bare-Root (BR) Plant Material

Minimum root spread shall be in accordance with ANLA ANSI/ANLA Z60.1. A well branched root system characteristic of the species specified shall be provided. Roots shall not be pulled from the ground. Bare-root plant material shall be inoculated with mycorrhizal fungi during germination in the nursery. Before shipment the root system shall be dipped in gels containing mycorrhizal fungi inoculum. Bare-root plant material shall be dormant. The root system shall be protected from drying out.

2.1.6.5 Container-Grown (C) Plant Material

Container size shall be in accordance with ANLA ANSI/ANLA Z60.1. Plant material shall be grown in a container over a duration of time for new fibrous roots to have developed and for the root mass to retain its shape and hold together when removed from the container. Container-grown plant material shall be inoculated with mycorrhizal fungi during germination in the nursery. Before shipment the root system shall be dipped in gels containing mycorrhizal fungi inoculum. The container shall be sufficiently rigid to hold ball shape and protect root mass during shipping.

2.1.7 Growth of Trunk and Crown

****
NOTE: The form of growth desired for specimen or special purpose plant material shall be described.
****

2.1.7.1 Deciduous Trees

A height to caliper relationship shall be provided in accordance with ANLA ANSI/ANLA Z60.1. Height of branching shall bear a relationship to the size and species of tree specified and with the crown in good balance with the trunk. The trees shall not be "poled" or the leader removed.

a. Single stem: The trunk shall be reasonably straight and symmetrical with crown and have a persistent main leader.

b. Multi-stem: All countable stems, in aggregate, shall average the size specified. To be considered a stem, there shall be no division of the trunk which branches more than 6 inches from ground level.

c. Specimen: The tree provided shall be well branched and pruned naturally according to the species. The form of growth desired, which may not be in accordance with natural growth habit, shall be as indicated.

2.1.7.2 Palms

Palms shall have the specified height as measured from the base of the trunk to the base of the fronds or foliage in accordance with ANLA ANSI/ANLA Z60.1. The palm shall have straight trunk and healthy fronds or foliage as typical for the variety grown in the region of the project. Palms trimmed or pruned for delivery shall retain a minimum of 6 inches of foliage at the crown as a means of determining plant health.

2.1.7.3 Deciduous Shrubs

Deciduous shrubs shall have the height and number of primary stems recommended by ANLA ANSI/ANLA Z60.1. Acceptable plant material shall be well shaped, with sufficient well-spaced side branches, and recognized by the trade as typical for the species grown in the region of the project.

2.1.7.4 Coniferous Evergreen Plant Material

Coniferous Evergreen plant material shall have the height-to-spread ratio recommended by ANLA ANSI/ANLA Z60.1. The coniferous evergreen trees shall not be "poled" or the leader removed. Acceptable plant material shall be exceptionally heavy, well shaped and trimmed to form a symmetrical and tightly knit plant. The form of growth desired shall be as indicated.

2.1.7.5 Broadleaf Evergreen Plant Material

Broadleaf evergreen plant material shall have the height-to-spread ratio recommended by ANLA ANSI/ANLA Z60.1. Acceptable plant material shall be well shaped and recognized by the trade as typical for the variety grown in the region of the project.

2.1.7.6 Ground Cover and Vine Plant Material

Ground cover and vine plant material shall have the minimum number of runners and length of runner recommended by ANLA ANSI/ANLA Z60.1. Plant material shall have heavy, well developed and balanced crown with vigorous, well developed root system and shall be furnished in containers.

2.1.8 Plant Material Size

Plant material shall be furnished in sizes indicated. Plant material larger in size than specified may be provided at no additional cost to the Government.

2.1.9 Plant Material Measurement

Plant material measurements shall be in accordance with ANLA ANSI/ANLA Z60.1.

2.2 TOPSOIL

Topsoil shall be as defined in ASTM D 5268. When available, the topsoil shall be the existing surface soil stripped and stockpiled onsite in accordance with Section 02300 EARTHWORK. When additional topsoil is required beyond the available topsoil from the stripping operation, topsoil shall be delivered and amended as recommended by the soil test for the plant material specified. Topsoil shall be free from slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 1-1/2 inch diameter. Topsoil shall be free from viable plants and plant parts.

2.3 SOIL AMENDMENTS

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NOTE: Soil amendments are materials necessary for individual plant health requirements which are incorporated into the soil during the planting operation.

Field experience may be used to choose soil amendments to meet the local growing conditions on the project site.

****

Soil amendments shall consist of pH adjuster, fertilizer, organic material and soil conditioners meeting the following requirements. Vermiculite is not recommended.

2.3.1 pH Adjuster

The pH adjuster shall be an agricultural liming material in accordance with ASTM C 602. These materials may be burnt lime, hydrated lime, ground limestone, or shells. The pH adjuster shall be used to create a favorable soil pH for the plant material specified.

2.3.1.1 Limestone

Limestone material shall contain a minimum calcium carbonate equivalent of

80 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 55 percent shall pass through a No. 60 sieve. To raise soil pH, ground limestone shall be used.

2.3.1.2 Hydrated Lime

Hydrated lime shall contain a minimum calcium carbonate equivalent of 110 percent. Gradation: A minimum 100 percent shall pass through a No. 8 sieve and a minimum 97 percent shall pass through a No. 60 sieve.

2.3.1.3 Burnt Lime

Burnt lime shall contain a minimum calcium carbonate equivalent of 140 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 35 percent shall pass through a No. 60 sieve.

2.3.2 Fertilizer

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NOTE: Phosphorous is the chemical most responsible for vigorous root growth. Recommended slow release fertilizers include the following ratios: 5-10-5 or 10-6-4.

****

[It shall be as recommended by the soil test] [The nutrients ratio shall be [_____] percent nitrogen, [_____] percent phosphorus, and [_____] percent potassium]. Fertilizer shall be controlled release commercial grade; free flowing, pellet or tablet form; uniform in composition; and consist of a nitrogen-phosphorus-potassium ratio. The fertilizer shall be derived from sulphur coated urea, urea formaldehyde, plastic or polymer coated pills, or isobutylenediurea (IBDU). Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients.

2.3.3 Organic Material

Organic material shall consist of either bonemeal, peat, rotted manure, decomposed wood derivatives, recycled compost, or worm castings.

2.3.3.1 Bonemeal

Bonemeal shall be a finely ground, steamed bone product containing from 2 to 4 percent nitrogen and 16 to 40 percent phosphoric acid.

2.3.3.2 Rotted Manure

Rotted manure shall be unleached horse, chicken, or cattle manure containing a maximum 25 percent by volume of straw, sawdust, or other bedding materials. Manure shall contain no chemicals or ingredients harmful to plants. The manure shall be heat treated to kill weed seeds and shall be free of stones, sticks, and soil.

2.3.3.3 Decomposed Wood Derivatives

Decomposed wood derivatives shall be ground bark, sawdust, or other wood waste material free of stones, sticks, and toxic substances harmful to plants, and stabilized with nitrogen.

2.3.3.4 Recycled Compost

Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from food, agricultural, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. The compost shall possess no objectionable odors and shall not resemble the raw material from which it was derived. The material shall not contain substances toxic to plants. Gradation: The compost material shall pass through a 3/8 inch screen, possess a pH of 5.5 to 8.0, and have a moisture content between 35-55 percent by weight. The material shall not contain more than 1 percent or less by weight of man-made foreign matter. Compost shall be cleaned of plastic materials larger than 2 inches in length.

2.3.3.5 Worm Castings

Worm castings shall be screened from worms and food source and shall be commercially packaged.

2.3.4 Soil Conditioner

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NOTE: Soil conditioners are inorganic materials used to alter the chemical or physical characteristics of the soil.

****

Soil conditioner shall be sand, super absorbent polymers, calcined clay, or gypsum for single use or in combination to meet topsoil requirements for the plant material specified.

2.3.4.1 Sand

Sand shall be clean and free of toxic materials. Gradation: A minimum 95 percent by weight shall pass a No. 10 sieve and a minimum 10 percent by weight shall pass a No. 16 sieve. Greensand shall be balanced with the inclusion of trace minerals and nutrients.

2.3.4.2 Super Absorbent Polymers

To improve water retention in soils, super absorbent polymers shall be sized according to manufacturer's recommendations. Polymers shall be added as a soil amendment and be cross-linked polyacrylamide with an absorption capacity of 250-400 times its weight.

2.3.4.3 Calcined Clay

Granular particles shall be produced from montmorillonite clay calcined to minimum temperature of 1200 degrees F. Gradation: A minimum 90 percent passing No. 8 sieve; a minimum 99 percent shall be retained on No. 60 sieve; and a maximum 2 percent shall pass a No. 100 sieve. Bulk density: A maximum 40 pounds per cubic foot.

2.3.4.4 Gypsum

Gypsum shall be commercially packaged, free flowing, and a minimum 95 percent calcium sulfate by volume.

2.3.4.5 Expanded Shale, Clay, or Slate (ESCS)

Rotary kiln produced ESCS material shall be in conformance with ASTM D 5883.

2.4 MULCH

****
NOTE: Select the type of mulch to be used. The selection of an inorganic mulch is based upon its purpose in the landscape design and designer preference for visual interest in the area.
****

Mulch shall be free from weeds, mold, and other deleterious materials. Mulch materials shall be native to the region. Rotted manure is not recommended to be used as a mulch because it would encourage surface rooting of the plant material and weeds.

2.4.1 Inorganic Mulch

When inorganic mulch is required for decorative purposes, it shall be provided in areas designated, and consist of:

a. [riverbank stone ranging in size from [_____] to [_____] inches]

b. [crusher run rock ranging in size from [_____] to [_____] inches]

c. [granite chips ranging in size from [_____] to [_____] inches]

d. [marble chips ranging in size from [_____] to [_____] inches]

e. [crushed bricks ranging in size from [_____] to [_____] inches]

f. [volcanic rock ranging in size from [_____] to [_____] inches]

g. [crushed shells ranging in size from [_____] to [_____] inches].

h. [recycled rubber, [shredded,] [chips,] colored [black] [_____] ranging in size from [_____] to [_____] inches].

2.4.2 Organic Mulch

Organic mulch materials shall be native to the project site and consist of recycled mulch, shredded bark, wood chips, or ground bark.

2.4.2.1 Recycled Mulch

Recycled mulch may include compost, tree trimmings, or pine needles with a gradation that passes through a 2-1/2 x 2-1/2 inch screen. It shall be cleaned of all sticks a minimum 1 inch in diameter and plastic materials a minimum 3 inch length. The material shall be treated to retard the growth of mold and fungi. Other recycled mulch may include peanut shells, pecan shells or coco bean shells.

2.4.2.2 Shredded Bark

Locally shredded material shall be treated to retard the growth of mold and fungi.

2.4.2.3 Wood Chips and Ground Bark

Locally chipped or ground material shall be treated to retard the growth of mold and fungi. Gradation: A maximum 2 inch wide by 4 inch long.

2.5 GEOTEXTILE

Geotextile shall be woven or nonwoven; polypropylene, polyester, or fiberglass, mat in accordance with ASTM D 5034 or ASTM D 5035. It shall be made specifically for use as a fabric around plant material. Nominal weight shall be a minimum 4 ounces per square yard. Permeability rate shall be a minimum 0.04 inch per second.

2.6 WOOD STAKING MATERIAL

Wood stakes shall be hardwood or fir; rough sawn; free from knots, rot, cross grain, or other defects that would impair their strength.

2.6.1 Bracing Stake

Wood bracing stakes shall be a minimum 2 x 2 inch square and a minimum 8 feet long with a point at one end. Stake shall be set without damaging rootball.

2.6.2 Wood Ground Stakes

Wood ground stakes shall be a minimum of 2 x 2 inch square and a minimum 3 feet long with a point at one end.

2.6.3 Deadmen

Wood deadmen shall be a minimum 4 x 4 x 36 inches long.

2.7 METAL STAKING AND GUYING MATERIAL

Metal shall be aluminum or steel consisting of recycled content made for holding plant material in place.

2.7.1 Bracing Stakes

Metal bracing stakes shall be a minimum 1 inch diameter and a minimum 8 feet long. Stake shall be set without damaging rootball.

2.7.2 Metal Ground Stakes

Metal ground stakes shall be a minimum 1/2 inch diameter and a minimum 3 feet long.

2.7.3 Earth Anchor

Metal earth anchors shall be a minimum 1/2 inch diameter and a minimum 2 feet long.

2.7.4 Guying Material

Metal guying material shall be a minimum 12 gauge wire. Multi-strand cable shall be woven wire. Guying material tensile strength shall conform to the size of tree to be held firmly in place.

2.7.5 Turnbuckle

Metal turnbuckles shall be galvanized or cadmium-plated steel, and shall be a minimum 3 inches long with closed screw eyes on each end. Screw thread tensile strength shall conform to the size of tree to be held firmly in place.

2.8 PLASTIC STAKING AND GUYING MATERIAL

Plastic shall consist of recycled plastic product made for holding plant material firmly in place. Plastic shall not be used for deadmen.

2.8.1 Plastic Bracing Stake

Plastic bracing stakes shall be a minimum 2 inch diameter and a minimum 8 feet long. Stake shall be set without damaging rootball.

2.8.2 Plastic Ground Stakes

Plastic ground stakes shall be a minimum 1 inch diameter and a minimum 3 feet long.

2.8.3 Plastic Guying Material

Plastic guying material shall be designed specifically for the purpose of firmly holding plant material in high wind velocities.

2.8.4 Chafing Guard

Plastic chafing guards shall be used to protect tree trunks and branches when metal is used as guying material. The material shall be the same color throughout the project site. Length shall be a minimum 1.5 times the circumference of the plant trunk at its base.

2.9 RUBBER GUYING MATERIAL

Rubber chafing guards, consisting of recycled material, shall be used to protect tree trunks and branches when metal guying material is applied. The material shall be the same color throughout the project. Length shall be a minimum 1.5 times the circumference of the plant trunk at its base.

2.10 FLAG

Plastic flag material shall be used on guying material. It shall be a minimum 6 inches long. Tape color shall be consistent and visually complimentary to the entire project area. The tape color shall meet pedestrian visual safety requirements for day and night.

2.11 TREE ROOT BARRIERS

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NOTE: Tree root barrier selection should be based on proven effectiveness of the product and onsite specific conditions.

****

Tree root barriers shall be metal or plastic consisting of recycled content. Barriers shall utilize vertical stabilizing members to encourage downward tree root growth. Barriers shall limit, by a minimum 90 percent, the occurrence of surface roots. Tree root barriers which are designed to be used as plant pit liners will be rejected.

2.12 MYCORRHIZAL FUNGI INOCULUM

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NOTE: Mycorrhizal fungi inoculum has been proven to be beneficial and found around the roots of native plant material. The fungi aid plant material in nutrient absorption and water retention. These fungi are rarely present in nursery grown plant material because the growing media may be sterile.
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Mycorrhizal fungi inoculum shall be composed of multiple-fungus inoculum as recommended by the manufacturer for the plant material specified.

2.13 WATER

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NOTE: When water is Government furnished, locate the source.
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Unless otherwise directed, water shall be the responsibility of the Contractor. Water shall not contain elements toxic to plant life.

2.14 PESTICIDE

Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide or miticide. For the purpose of this specification a soil fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved.

PART 3 EXECUTION

3.1 INSTALLING PLANT MATERIAL TIME AND CONDITIONS

3.1.1 Deciduous Plant Material Time

Deciduous plant material shall be installed from [_____] to [_____].

3.1.2 Evergreen Plant Material Time

Evergreen plant material shall be installed from [_____] to [_____].

3.1.3 Plant Material Conditions

Planting operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the planting operations, proposed planting times shall be submitted for approval.

3.1.4 Tests

3.1.4.1 Percolation Test

Test for percolation shall be done to determine positive drainage of plant pits and beds. A positive percolation shall consist of a minimum 1 inch per 3 hours; when a negative percolation test occurs, a shop drawing shall be submitted indicating the corrective measures.

3.1.4.2 Soil Test

Delivered topsoil, excavated plant pit soil, and stockpiled topsoil shall be tested in accordance with ASTM D 5268 and ASTM D 4972 for determining the particle size, pH, organic matter content, textural class, chemical analysis, soluble salts analysis, and mechanical analysis. Sample collection onsite shall be random over the entire site. Sample collection for stockpiled topsoil shall be at different levels in the stockpile. The soil shall be free from debris, noxious weeds, toxic substances, or other materials harmful to plant growth. The test shall determine the quantities and type of soil amendments required to meet local growing conditions for the plant material specified.

3.2 SITE PREPARATION

3.2.1 Finished Grade, Topsoil and Underground Utilities

****

NOTE: Coordinate the placement of topsoil with Section 02300 EARTHWORK. When stockpiled topsoil is limited, define the areas that will use this soil. It is not necessary to topsoil all areas to be seeded; the smooth graded areas can be amended with soil amendments to meet local growing conditions for the seed specified. This procedure may be more cost effective. Coordinate the topsoil requirements with Section 02921 SEEDING, Section 02922 SODDING and Section 02923 SPRIGGING.

****

The Contractor shall verify that finished grades are as indicated on drawings, and that the placing of topsoil, the smooth grading, and the compaction requirements have been completed in accordance with Section 02300 EARTHWORK, prior to the commencement of the planting operation. The location of underground utilities and facilities in the area of the planting operation shall be verified. Damage to underground utilities and facilities shall be repaired at the Contractor's expense.

3.2.2 Layout

Plant material locations and bed outlines shall be staked on the project site before any excavation is made. Plant material locations may be adjusted to meet field conditions.

3.2.3 Protecting Existing Vegetation

When there are established lawns in the planting area, the turf shall be covered and/or protected during planting operations. Existing trees, shrubs, and plant beds that are to be preserved shall be barricaded along the dripline to protect them during planting operations.

3.3 EXCAVATION

3.3.1 Obstructions Below Ground

When obstructions below ground affect the work, shop drawings showing proposed adjustments to plant material location, type of plant and planting method shall be submitted for approval.

3.3.2   Turf Removal

Where the planting operation occurs in an existing lawn area, the turf shall be removed from the excavation area to a depth that will ensure the removal of the entire root system.

3.3.3   Plant Pits

Plant pits for ball and burlapped or container plant material shall be dug to a depth equal to the height of the root ball as measured from the base of the ball to the base of the plant trunk. Plant pits for bare-root plant material shall be dug to a depth equal to the height of the root system. Plant pits shall be dug a minimum 50 percent wider than the ball or root system to allow for root expansion. The pit shall be constructed with sides sloping towards the base as a cone, to encourage well aerated soil to be available to the root system for favorable root growth. Cylindrical pits with vertical sides shall not be used.

3.4   INSTALLATION

3.4.1   Setting Plant Material

Plant material shall be set plumb and held in position until sufficient soil has been firmly placed around root system or ball. In relation to the surrounding grade, the plant material shall be set even with the grade at which it was grown.

3.4.1.1   Bare-Root Plant Material

Bare-root plant material shall be placed in water a minimum 30 minutes prior to setting.

3.4.2   Tree Root Barrier

Tree root barriers shall be installed as recommended by the manufacturer. Tree root barriers shall be used for trees located up to a maximum 6 feet from paved surfaces or structures.

3.4.3   Backfill Soil Mixture

****

NOTE: The current trend in the horticultural trade has established that the root system is more likely to grow into the soils surrounding the plant pit when the backfill soil mixture is not amended and of similar composition to the excavated plant pit soil. Specify special soil mixtures for containers in this paragraph. When the weight of soil mixture is a concern, perlite should be used to reduce the quantity of soil.

****

The backfill soil mixture may be a mix of topsoil and soil amendments suitable for the plant material specified. When practical, the excavated soil from the plant pit that is not amended provides the best backfill and shall be used.

3.4.4 Adding Mycorrhizal Fungi Inoculum

Mycorrhizal fungi inoculum shall be added as recommended by the manufacturer for the plant material specified.

3.4.5 Backfill Procedure

Prior to backfilling, all metal, wood, synthetic products, or treated burlap devices shall be removed from the ball or root system avoiding damage to the root system. The backfill procedure shall remove air pockets from around the root system. Additional requirements are as follows.

3.4.5.1 Balled and Burlapped, and Balled and Platformed Plant Material

Biodegradable burlap and tying material shall be carefully opened and folded back from the top a minimum 1/3 depth from the top of the root ball. Backfill mixture shall be added to the plant pit in 6 inch layers with each layer tamped.

3.4.5.2 Bare-Root Plant Material

The root system shall be spread out and arranged in its natural position. Damaged roots shall be removed with a clean cut. The backfill soil mixture shall be carefully worked in amongst the roots and watered to form a soupy mixture. Air pockets shall be removed from around the root system, and root to soil contact shall be provided.

3.4.5.3 Container-Grown and Balled and Potted Plant Material

The plant material shall be carefully removed from containers that are not biodegradeable. Prior to setting the plant in the pit, a maximum 1/4 depth of the root mass, measured from the bottom, shall be spread apart to promote new root growth. For plant material in biodegradable containers the container shall be split prior to setting the plant with container. Backfill mixture shall be added to the plant pit in 6 inch layers with each layer tamped.

3.4.5.4 Earth Berm

An earth berm, consisting of backfill soil mixture, shall be formed with a minimum 4 inch height around the edge of the plant pit to aid in water retention and to provide soil for settling adjustments.

3.4.6 Plant Bed

Plant material shall be set in plant beds according to the drawings. Backfill soil mixture shall be placed on previously scarified subsoil to completely surround the root balls, and shall be brought to a smooth and even surface, blending to existing areas. Earth berms shall be provided. Polymers shall be spread uniformly over the plant bed and in the planting pit as recommended by the manufacturer and thoroughly incorporated into the soil to a maximum 4 inch depth.

3.4.7 Watering

Plant pits and plant beds shall be watered immediately after backfilling, until completely saturated.

3.4.8 Staking and Guying

****

NOTE: The current trend in the horticultural trade has established that staking and guying trees should not be provided unless there is high wind velocity at the project site. The current trend in the horticultural trade has established that tree wrap should not be provided.

****

Staking will be required when trees are unstable or will not remain set due to their size, shape, or exposure to high wind velocity.

3.4.8.1 One Bracing Stake

Trees 4 to 6 feet high shall be firmly anchored in place with one bracing stake. The bracing stake shall be placed on the side of the tree facing the prevailing wind. The bracing stake shall be driven vertically into firm ground and shall not injure the ball or root system. The tree shall be held firmly to the stake with a double strand of guying material. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. A chafing guard shall be used when metal is the guying material.

3.4.8.2 Two Bracing Stakes

Trees from 6 to 8 feet height shall be firmly anchored in place with 2 bracing stakes placed on opposite sides. Bracing stakes shall be driven vertically into firm ground and shall not injure the ball or root system. The tree shall be held firmly between the stakes with a double strand of guying material. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. Chafing guards shall be used when metal is the guying material.

3.4.8.3 Three Ground Stakes

Trees over a minimum 8 feet height and less than a maximum 6 inch caliper shall be held firmly in place with 3 bracing or ground stakes spaced equidistantly around the tree. Ground stakes shall be avoided in areas to be mowed. Stakes shall be driven into firm ground outside the earth berm. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. For trees over maximum 3 inch diameter at breast height, turnbuckles shall be used on the guying material for tree straightening purposes. One turnbuckle shall be centered on each guy line. Chafing guards shall be used when metal is the guying material.

3.4.9 Deadmen or Earth Anchors

Trees over a minimum 6 inch caliper shall be held firmly in place with wood deadmen buried a minimum 3 feet in the ground or metal earth anchors. Multi-strand cable guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. Turnbuckles shall be used on the guying material for tree straightening purposes. One turnbuckle shall be centered on each guy line. Chafing guards shall be used.

3.4.10 Flags

A flag shall be securely fastened to each guy line equidistant between the tree and the stake, deadmen, or earth anchor. The flag shall be visible to pedestrians.

3.5 FINISHING

3.5.1 Plant Material

Prior to placing mulch, the installed area shall be uniformly edged to provide a clear division line between the planted area and the adjacent turf area, shaped as indicated. The installed area shall be raked and smoothed while maintaining the earth berms.

3.5.2 Placing Geotextile

Prior to placing mulch, geotextile shall be placed as indicated in accordance with the manufacturer's recommendations.

3.5.3 Placing Mulch

The placement of mulch shall occur a maximum 48 hours after planting. Mulch, used to reduce soil water loss, regulate soil temperature and prevent weed growth, shall be spread to cover the installed area with a minimum 4 inch uniform thickness. Mulch shall be kept out of the crowns of shrubs, ground cover, and vines and shall be kept off buildings, sidewalks and other facilities.

3.5.4 Pruning

****

NOTE: The current trend in the horticultural trade has established that wound dressing or pruning paint should not be provided. These procedures do not contribute to wound closure or the compartmentalization process.

****

Pruning shall be accomplished by trained and experienced personnel. The pruning of trees and palms shall be in accordance with ANSI A300. Only dead or broken material shall be pruned from installed plants. The typical growth habit of individual plant material shall be retained. Clean cuts shall be made flush with the parent trunk. Improper cuts, stubs, dead and broken branches shall be removed. "Headback" cuts at right angles to the line of growth will not be permitted. Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off".

3.6 MAINTENANCE DURING PLANTING OPERATION

Installed plant material shall be maintained in a healthy growing condition. Maintenance operations shall begin immediately after each plant is installed to prevent desiccation and shall continue until the plant establishment period commences. Installed areas shall be kept free of weeds, grass, and other undesired vegetation. The maintenance includes maintaining the mulch, watering, and adjusting settling.

3.7 APPLICATION OF PESTICIDE

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NOTE: When a pest is known to be in the soil, identify the pest and the area to be treated.
****

When application of a pesticide becomes necessary to remove a pest or disease, a pesticide treatment plan shall be submitted and coordinated with the installation pest management program.

3.7.1 Technical Representative

The certified installation pest management coordinator shall be the technical representative, and shall be present at all meetings concerning treatment measures for pest or disease control. They may be present during treatment application.

3.7.2 Application

A state certified applicator shall apply required pesticides in accordance with EPA label restrictions and recommendations. Clothing and personal protective equipment shall be used as specified on the pesticide label. A closed system is recommended as it prevents the pesticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying pesticide shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately.

3.8 RESTORATION AND CLEAN UP

3.8.1 Restoration

Turf areas, pavements and facilities that have been damaged from the planting operation shall be restored to original condition at the Contractor's expense.

3.8.2 Clean Up

Excess and waste material shall be removed from the installed area and shall be disposed offsite. Adjacent paved areas shall be cleared.

3.9 PLANT ESTABLISHMENT PERIOD

3.9.1 Commencement

Upon completion of the last day of the planting operation, the plant establishment period for maintaining installed plant material in a healthy growing condition shall commence and shall be in effect for the remaining contract time period, not to exceed 12 months. Written calendar time period shall be furnished for the plant establishment period. When there is more than one plant establishment period, the boundaries of the planted area covered for each period shall be described. The plant establishment period shall be coordinated with Sections 02921 SEEDING; 02922 SODDING; and 02923 SPRIGGING. The plant establishment period shall be modified for inclement weather shut down periods, or for separate completion dates for areas.

3.9.2 Maintenance During Establishment Period

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NOTE: Check with the State Agricultural Experimental Station, Agricultural Extension Service, or other reputable agency for area specific recommendations on type and application rate for post-fertilization.
****

Maintenance of plant material shall include straightening plant material, straightening stakes; tightening guying material; correcting girdling; supplementing mulch; pruning dead or broken branch tips; maintaining plant material labels; watering; eradicating weeds, insects and disease; post-fertilization; and removing and replacing unhealthy plants.

3.9.2.1 Watering Plant Material

The plant material shall be watered as necessary to prevent desiccation and to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is estimated to be the equivalent of 1 inch absorbed water per week, delivered in the form of rain or augmented by watering. Run-off, puddling and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or existing plant material shall be prevented.

3.9.2.2 Weeding

Grass and weeds in the installed areas shall not be allowed to reach a maximum 3 inches height before being completely removed, including the root system.

3.9.2.3 Pesticide Treatment

Treatment for disease or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE.

3.9.2.4 Post-Fertilization

****
NOTE: This procedure enhances the establishment of the plant material. The post-fertilizer should provide a 5-3-2 or 1-2-1 nutrient ratio; for example: 10-6-4 or 5-10-5.
****

The plant material shall be topdressed at least once during the period of establishment with controlled release fertilizer, reference paragraph SOIL AMENDMENTS. Apply at the rate of 2 pounds per 100 square feet of plant pit or bed area. Dry fertilizer adhering to plants shall be flushed off. The application shall be timed prior to the advent of winter dormancy.

3.9.2.5 Plant Pit Settling

When settling occurs to the backfill soil mixture, additional backfill soil shall be added to the plant pit or plant bed until the backfill level is equal to the surrounding grade. Serious settling that affects the setting of the plant in relation to the maximum depth at which it was grown requires replanting in accordance with paragraph INSTALLATION. The earth berm shall be maintained.

3.9.2.6 Maintenance Record

A record shall be furnished describing the maintenance work performed, the quantity of plant losses, diagnosis of the plant loss, and the quantity of replacements made on each site visit.

3.9.3 Unhealthy Plant Material

A tree shall be considered unhealthy or dead when the main leader has died back, or up to a maximum 25 percent of the crown has died. A shrub shall be considered unhealthy or dead when up to a maximum 25 percent of the plant has died. This condition shall be determined by scraping on a branch an area 1/16 inch square, maximum, to determine if there is a green cambium layer below the bark. The Contractor shall determine the cause for unhealthy plant material and shall provide recommendations for replacement. Unhealthy or dead plant material shall be removed immediately and shall be replaced as soon as seasonal conditions permit.

3.9.4 Replacement Plant Material

Unless otherwise directed, plant material shall be provided for replacement in accordance with paragraph PLANT MATERIAL. Replacement plant material shall be installed in accordance with paragraph INSTALLATION, and recommendations in paragraph PLANT ESTABLISHMENT PERIOD. Plant material shall be replaced in accordance with paragraph WARRANTY. An extended plant establishment period shall not be required for replacement plant material.

3.9.5 Maintenance Instructions

Written instructions shall be furnished containing drawings and other necessary information for year-round care of the installed plant material; including, when and where maintenance should occur, and the procedures for plant material replacement,.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02951 (August 1997)**
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CEGS-02587 (June 1992)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02951

RUNWAY RUBBER REMOVAL
08/97

****
NOTE: This guide specification covers the requirements for runway rubber removal. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation: submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330SUBMITTAL PROCEDURES:

SD-01 Data

Rubber Removal Equipment; [_____].

A list of construction equipment including item names and descriptions.

SD-08 Statements

Runway Rubber Removal; [_____].

Statements regarding the suitability of materials, personnel, and methods proposed to accomplish the work.

1.2 MAINTENANCE OF TRAFFIC

1.2.1 Operation and Performance

The operation of equipment and the performance of work upon and in the vicinity of airfields shall be coordinated with the Contracting Officer and with the Flight Operations Officer. Neither equipment nor personnel shall use any portion of an airfield without permission of these officers unless the runway is closed. In all cases, verbal communication shall be maintained with the control tower before and during work in the vicinity of the airfield. The control tower shall be advised when work is completed. Runways will be closed during the following times:

Day or Date	Runway Closing Time	Runway Opening Time	Important Notes
[_____]	[_____]	[_____]	[_____]

1.2.2 Landing and Take-Offs

Emergency landings and take-offs shall take precedence over all Contractor operations. When notified of an emergency situation, the Contractor shall cease all rubber removal operations and immediately clear the runway of all equipment and personnel for a distance of at least 200 feet from the edge of the runway.

1.3 RUBBER REMOVAL EQUIPMENT

1.3.1 Mechanical Rubber Removal Equipment

Mechanical rubber removal equipment includes waterblasting, shotblasting, sandblasting, or other approved nonchemical systems. Equipment to be used on asphalt or tar concrete shall be controlled to remove rubber accumulations and minimize disturbance to asphalt or tar mixtures. Equipment to be used on portland cement concretes shall be controlled to remove rubber accumulations and prevent removal of hardened paste from the concrete. Basic hand tools and the following major types of mechanical equipment will be considered acceptable for this project.

1.3.1.1 Waterblasting Equipment

Mobile waterblasting equipment shall be capable of producing a pressurized stream of water that will effectively remove rubber from the pavement surface without significantly damaging the pavement. Water pressure shall be regulated so that substantially all rubber accumulations are removed during execution of the work.

1.3.1.2 Shotblasting Equipment

Mobile self propelled shotblasting equipment shall be capable of producing an adjustable depth of rubber removal. The equipment shall be capable of propelling abrasive particles at high velocities on the rubber for effective removal. Each unit shall be self cleaning and self contained. The equipment shall be able to confine the abrasive, any dust that is produced, and removed rubber; and shall be capable of recycling the abrasive for reuse.

1.3.1.3 Sandblasting Equipment

Mobile sandblasting equipment shall be capable of producing a pressurized stream of sand and air that will effectively remove rubber from the pavement surface without filling voids with debris in asphalt or tar pavements or removing joint sealants in portland cement concrete pavements. The equipment shall include an air compressor, hoses, and nozzles of adequate size and capacity for removing all rubber. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water, and shall be capable of furnishing a flow rate of at least 150 cubic feet per minute of air at a pressure of at least 90 pounds per square inch at each nozzle.

1.3.2 Chemical Rubber Removal Equipment

Chemical equipment shall be capable of application and removal of chemicals from the pavement surface and shall leave only non-toxic biodegradable residue.

1.4 DELIVERY AND STORAGE

Materials that are required in the approved rubber removal process shall be delivered in original manufacturer's containers and shall be labeled with appropriate EPA, OSHA, or other agency warnings, if applicable. Materials shall be protected from the environment until their use is required during execution of the work.

1.5 UNIT PRICES

1.5.1 Measurement

Rubber removal will be measured by the number of square feetof runway to be cleaned.

1.5.2 Payment

Rubber removal will be paid for at the contract unit price per square foot of runway rubber removed.

1.6 WEATHER LIMITATIONS

Pavement surface shall be free of snow, ice or slush. Surface temperature shall be at least 40 degrees F and rising at the beginning of operations except those involving shotblasting or sandblasting for which a lower surface temperature may be approved. Operation shall cease during thunderstorms. Operation shall cease during rainfall except for waterblasting and removal of previously applied chemicals. Waterblasting shall cease where surface water accumulation alters the effectiveness of material removal.

PART 2   PRODUCTS (Not Applicable)

PART 3   EXECUTION

****

NOTE: The Contracting Officer, the airport administrator and the pavements engineer will jointly develop guidelines and requirements for rubber removal operations; and will jointly evaluate the feasibility of the Contractor's methods and project compliance with applicable regulations.

****

3.1   RUBBER REMOVAL

The pavement surface may be of portland cement, tar or asphalt mixtures. Chemical methods, if used, shall be compatible with pavement materials, the environment and working personnel. Close control of water pressure and blasting time/duration shall be used to prevent disintegration damage to asphalt and tar concretes. Extremely good control shall be exercised for porous friction courses. The Contractor shall demonstrate the ability to remove rubber at a touchdown area of the runway selected by the Contracting Officer; at least one site per runway will be chosen. Rubber removal shall be as complete as possible without damage to the pavement surface. The surface texture of the cleaned demonstration area will be compared to that of nonrubber traffic areas to determine satisfactory completion of the removal operation. After approval of the Contractor's operations the cleaned area will become the standard for rubber removal and final surface texture for the remainder of work.

3.2   CLEANUP AND WASTE DISPOSAL

The worksite shall be kept clean of debris and waste from rubber removal operations. Cleanup operations shall be continuous. Debris and waste materials shall be accumulated and disposed at approved sites.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-02975 (July 1997)**
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Superseding
CEGS-02594 (February 1991)

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CEGS-02594 (February 1991)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 02975

SEALING OF CRACKS IN BITUMINOUS PAVEMENTS
07/97

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NOTE: This guide specification covers the requirements for sealing cracks in bituminous pavements. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: For additional information concerning bituminous pavements, see TM 5-822-8, "Bituminous Pavements Standard Practice."
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in this text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 509	(1994) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM D 789	(1994) Determination of Relative Viscosity, Melting Point, and Moisture Content of Polyamide (PA)
ASTM D 1190	(1994) Concrete Joint Sealer, Hot-Poured Elastic Type
ASTM D 3405	(1994) Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements

1.2 UNIT PRICES

****

NOTE: Paragraphs Measurement and Payment will be deleted for lump sum bidding.

****

1.2.1 Measurement

The quantity of each sealing item to be paid for shall be determined by actual measurement of the number of linear feet of in-place material that has been approved.

1.2.2 Payment

Payment shall be made at the contract unit bid prices per linear foot for the sealing items scheduled. The unit bid prices shall include the cost of all labor, materials, and the use of all equipment and tools required to complete the work.

1.3 SYSTEM DESCRIPTION

Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and shall be maintained in satisfactory condition at all times.

1.4 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

Installation of Sealant; [_____].

Manufacturer's instructions [_____] days prior to the use of the material on the project. Installation of the material will not be allowed until the instructions are received.

SD-09 Reports

Test Requirements; [_____].

Reports of all tests. [Testing of the materials shall be performed in an approval independent laboratory and certified copies of the test reports shall be submitted and approved [_____] days prior to the use of the materials at the job site. Samples will be retained by the Government for possible future testing should the materials appear defective during or after application.]

SD-14 Samples

Materials; GA.

Samples of the materials [60] [_____] days prior to their use on the project. No material will be allowed to be used until it has been approved.

1.5 TEST REQUIREMENTS

The crack sealant and backup material, when required, shall be tested for conformance with the referenced applicable material specification. [The materials will be tested by the Government. The cost of the first test of samples will be borne by the Government. If the samples fail to meet specification requirements, the Contractor shall replace the materials represented by the sample and the new materials shall be tested at the Contractor's expense.] Samples of materials shall be furnished, in sufficient quantity to be tested, upon request. Conformance with the requirements of the laboratory tests specified will not constitute final acceptance of the materials. Final acceptance will be based on the performance of the in-place materials.

1.6 EQUIPMENT

Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and shall be maintained in satisfactory condition at all times.

1.6.1 Crack Cleaning Equipment

1.6.1.1 Routing Equipment

****

NOTE: Rotary impact routers that are equipped with vertical sided, carbide tipped bits have been used successfully to rout cracks in bituminous pavements.

Impact routers that are not equipped with carbide tipped bits normally chip and damage the surrounding pavement and should not be permitted.
****

The routing equipment shall be a self-powered machine operating a power driven tool or bit specifically designed for routing bituminous pavements. The bit shall rotate about a vertical axis at sufficient speed to cut a smooth vertical-walled reservoir in the pavement surface and shall maintain accurate cutting without damaging the sides or top edges of the reservoir. The router shall be capable of following the trace of the crack without deviation. [The use of rotary impact routing devices will not be permitted for cleaning cracks.] [The use of rotary impact routing devices may be permitted if vertical-sided carbide tipped bits are used.]

1.6.1.2 Concrete Saw

A self-propelled power saw with small diameter (6 inches or less) water-cooled diamond or abrasive saw blades shall be provided for cutting cracks to the depths and widths specified and for removing filler that is embedded in the cracks or adhered to the crack faces. The diameter of the saw blade shall be small enough to allow the saw to closely follow the trace of the crack.

1.6.1.3 Sandblasting Equipment

****
NOTE: Sandblasting of cracks may not be permitted under certain conditions. Blowing sand and dust may either violate atmospheric pollution statues, or may drift into areas where it would be objectionable. When sandblasting is prohibited, cleaning the cracks with waterblasting equipment or wire brushes may be substituted. If wire brushes are used, attention should be given to ensure that worn brushes are not used. Waterblasting equipment varies considerably with respect to design of wand, nozzle, water pressure, and water volume depending on the manufacturer. Consequently, the effectiveness of a particular set of equipment cannot be predicted. The Contractor should demonstrate his equipment to show that it will clean the crack satisfactorily before being allowed to proceed.
****

Sandblasting equipment shall include an air compressor, hose, and long-wearing venturi-type nozzle of proper size, shape and opening. The maximum nozzle opening shall not exceed 1/4 inch.The air compressor shall be portable; and shall be capable of furnishing not less than 150 cfm and maintaining a line pressure of not less than 90 psi at the nozzle while in use. Compressor capability under job conditions shall be demonstrated before approval. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the crack about 1 inch above the pavement surface. The height, angle of inclination and the size of the nozzle shall be adjusted as necessary to secure satisfactory results.

1.6.1.4   Waterblasting Equipment

Waterblasting equipment shall include a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water resupply equipment. The water tank and auxiliary resupply equipment shall be of sufficient capacity to permit continuous operations. The hose, wand, and nozzle shall be capable of cleaning the crack faces and the pavement surface on both sides of the crack for a width of at least 1/2 inch. A pressure gauge mounted at the pump shall show at all times the pressure in pounds per square inch at which the equipment is operating.

1.6.1.5   Hand Tools

****

NOTE: In areas that have cracks larger than 37 mm (1-1/2 inches), it may be necessary to employ other types of small tools to remove damaged asphalt or crack sealant material. Such tools should be carefully evaluated for potential damaging effects to adjacent pavement prior to approval for use. For repairing bituminous pavements, the Designer is referred to Technical Manual 5-624.

****

Hand tools may be used, when approved, for removing defective sealant from cracks and repairing or cleaning the crack faces.

1.6.2   Crack Sealing Equipment

The unit applicators used for heating and installing the hot-poured crack sealant materials shall be mobile and shall be equipped with a double-boiler, agitator-type kettle with an oil medium in the outer space for heat transfer; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the crack to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording type thermometer for indicating the temperature of the sealant. The applicator unit design shall allow the sealant to circulate through the delivery hose and return to the inner kettle when not in use.

1.7   DELIVERY AND STORAGE

Materials delivered to the job site shall be inspected for defects, unloaded, and stored with a minimum of handling to avoid damage. Storage facilities shall be provided at the job site to protect materials from weather and to maintain them at the temperatures recommended by the manufacturer.

1.8   ENVIRONMENTAL CONDITIONS

The ambient air temperature and the pavement temperature within the joint wall shall be a minimum of 50 degrees F and rising at the time of application of the materials. Sealant shall not be applied if moisture is observed in the crack.

PART 2   PRODUCTS

2.1   SEALANTS

****

NOTE: Select crack sealants based on the proposed use and local experience. ASTM D 3405 sealants are normally higher quality and more expensive than ASTM D 1190 materials. When the area will experience pedestrian traffic, ASTM D 3405 sealant should be specified because it has a higher modulus of elasticity and therefore should not adhere to pedestrians' shoes.

If the bituminous pavement is covered by a fuel-resistant pavement sealer, the cracks should be sealed using the above mentioned sealants and then covered by a fuel-resistant pavement sealer. Fuel-resistant crack sealants should not be used in asphalt pavements for compatibility reasons.

****

Sealants shall conform to ASTM D 3405 or ASTM D 1190. Usage of sealing materials for sealing cracks in the various paved areas indicated on the drawings shall be as follows:

Area	Sealing Material
[_____]	[ASTM D 3405]
[_____]	[ASTM D 1190]

2.2 BACKUP MATERIALS

****

NOTE: The use of backup materials in bituminous pavements is to maintain a sealant reservoir depth of approximately 20 mm (3/4 inch). Backup material is not required in cracks with a sealant reservoir depth of less than 20 mm (3/4 inch).

****

Backup material shall be a compressible, nonshrinking, nonstaining, nonabsorptive material and shall be nonreactive with the crack sealant. The melting point of the backing material shall be at least 5 degrees F greater than the maximum pouring temperature of the sealant being used, when tested in accordance with ASTM D 789. The material shall have a water absorption of not more than 5 percent by weight when tested in accordance with ASTM C 509. The backup material shall be 25 percent (plus or minus 5 percent) larger in diameter than the nominal width of the crack.

PART 3 EXECUTION

3.1 PREPARATION OF CRACKS

****

NOTE: In bituminous pavements that have large quantities of hairline cracks or cracks less than 6 mm (1/4 inch), a bituminous fog coat or a bituminous

seal coat should be used to prevent water intrusion into the base material. The Designer is referred to Technical Manual 5-624, Section 02745 BITUMINOUS SURFACE TREATMENT and Section 02785 BITUMINOUS SEAL COAT, SPRAY APPLICATION. If the pavement being sealed is to receive a hot asphalt concrete overlay, then small cracks should not be sealed. Medium and large cracks can be filled or sealed. Prior to the overlay, the cracks can be filled using a slurry mixture of sand and emulsion. It should be noted that this is a crack filler not a crack sealant; therefore, it should only be used when the pavement will receive an overlay. The cracks should be filled or sealed to a depth of 6 mm (1/4 inch) below the pavement surface to prevent "bleeding" of the material through the overlay. If the cracks are overfilled, the sealant material will be tracked onto the pavement.

****

Immediately before the installation of the crack sealant, the cracks shall be thoroughly cleaned to remove oxidized pavement, loose aggregate and foreign debris. The preparation shall be as follows:

3.1.1 Cracks

3.1.1.1 Hairline Cracks

Cracks that are less than 1/4 inch wide [do not need to be sealed] [shall be sealed in accordance with Section [_____]].

3.1.1.2 Small Cracks

Cracks that are 1/4 to 3/4 inch wide shall be routed to a nominal width 1/8 inch greater than the existing nominal width and to a depth not less than 3/4 inch, [sandblasted] [waterblasted] [wire brushed] and cleaned using compressed air.

3.1.1.3 Medium Cracks

Cracks that are 3/4 to 2 inches wide shall be [sandblasted] [waterblasted] [wire brushed] and cleaned using compressed air.

3.1.1.4 Large Cracks

Cracks that are greater than 2 inches wide shall be repaired using pothole repair techniques instead of sealing.

3.1.2 Existing Sealant Removal

****

NOTE: This paragraph shall be deleted and subsequent paragraphs renumbered if the cracks have never been sealed in the past.

****

The in-place sealant shall be cut loose from both crack faces and to a depth shown on the drawings, using a concrete saw or hand tools as specified in paragraph EQUIPMENT. Depth shall be sufficient to accommodate any backup material that is required to maintain the depth of new sealant to be installed. Prior to further cleaning operations, all old loose sealant remaining in the crack opening shall be removed by blowing with compressed air.

3.1.3 Routing

Routing of the cracks shall be accomplished using a rotary router with a bit that is at least 1/8 inch wider than the nominal width of the crack to remove all residual old sealant (resealing), oxidized pavement and any loose aggregate in the crack wall.

3.1.4 Sawing

Sawing of the cracks shall be accomplished using a power-driving concrete saw as specified in paragraph EQUIPMENT. The blade shall be stiffened as necessary with suitable dummy (or used) blades or washers. Immediately following the sawing operation, the crack opening shall be cleaned using a water jet to remove all saw cuttings and debris.

3.1.5 Sandblasting

****

NOTE: When waterblasting is required instead of sandblasting, replace the word "sandblasting" with "waterblasting."

****

The crack faces and the pavement surfaces extending a minimum of 1/2 inch from the crack edges shall be sandblasted clean. A multiple-pass technique shall be used until the surfaces are free of dust, dirt, old sealant residue, or foreign debris that might prevent the sealant material from bonding to the asphalt pavement. After final cleaning and immediately prior to sealing, the cracks shall be blown out with compressed air and left completely free of debris and water. The Contractor shall ensure that sandblasting does not damage the pavement.

3.1.6 Backup Material

Backup material shall be used on all cracks that have a depth greater than 3/4 inch. The backup material shall be inserted into the lower portion of the crack as shown on the drawings. The Contractor shall ensure that the backup material is placed at the specified depth and is not stretched or twisted during installation.

3.1.7 Rate of Progress of Crack Preparation

The stages of crack preparation which include routing, sandblasting of the crack faces, air pressure cleaning and placing of the backup material shall be limited to only that linear footage that can be sealed during the same day.

3.2 PREPARATION OF SEALANT

Hot-poured sealants shall not be heated in excess of the safe heating temperature recommended by the manufacturer as shown on the sealant containers. Sealant that has been overheated or subjected to application temperatures for over 4 hours or that has remained in the applicator at the end of the day's operation shall be withdrawn and wasted.

3.3 INSTALLATION OF SEALANT

3.3.1 Time of Application

Cracks shall be sealed immediately following final cleaning of the crack walls and following the placement of the backup material (when required). Cracks that cannot be sealed under the conditions specified, or when rain interrupts sealing operations, shall be recleaned and allowed to dry prior to installing the sealant.

3.3.2 Sealing the Crack

****

NOTE: Cracks should be slightly underfilled to preclude tracking the material onto the pavement surface. For airfield pavements, the sealant should be recessed 3 mm (1/8 inch) below the pavement surface; for roads, streets and parking lots, the sealant should be recessed 6 mm (1/4 inch). For pavements that are to receive an overlay, the sealant should be recessed a minimum of 6 mm (1/4 inch) and a maximum of 13 mm (1/2 inch) below the pavement surface.

****

Immediately preceding, but not more than 50 feet ahead of the crack sealing operations, a final cleaning with compressed air shall be performed. The cracks shall be filled from the bottom up to [1/8] [1/4] inch below the pavement surface. Excess or spilled sealant shall be removed from the pavement by approved methods and shall be discarded. The sealant shall be installed in a manner which prevents the formation of voids and entrapped air. Several passes with the applicator wand may be necessary to obtain the specified sealant depth from the pavement surface. Gravity methods or pouring pots shall not be used to install the sealant material. Traffic shall not be permitted over newly sealed pavement until authorized by the Contracting Officer. Cracks shall be checked frequently to ensure that the newly installed sealant is cured to a tack-free condition within 3 hours.

3.4 CRACK SEALANT INSTALLATION TEST SECTION

Prior to the cleaning and sealing of the cracks for the entire project, a test section at least 200 feet long shall be prepared using the specified materials and approved equipment, to demonstrate the proposed sealing of all cracks of the project. Following the completion of the test section and before any other crack is sealed, the test section will be inspected to determine that the materials and installation meet the requirements specified. If materials or installation do not meet requirements, the materials shall be removed and the cracks recleaned and resealed at no cost to the Government. When the test section meets the requirements, it may be incorporated into the permanent work and paid for at the contract unit price per linear foot for sealing items scheduled. All other cracks shall be sealed in the manner approved for sealing the test section.

3.5 CLEANUP

Upon completion of the project, unused materials shall be removed from the site and the pavement shall be left in a clean condition.

3.6 QUALITY CONTROL PROVISIONS

3.6.1 Crack Cleaning

Quality control provisions shall be provided during the crack cleaning process to correct improper equipment and cleaning techniques that damage the bituminous pavement in any manner. Cleaned cracks shall be approved prior to installation of the crack sealant.

3.6.2 Crack Seal Application Equipment

The application equipment shall be inspected to ensure conformance to temperature requirements and proper installation. Evidences of bubbling, improper installing, and failing to cure or set shall be cause to suspend operations until causes of the deficiencies are determined and corrected.

3.6.3 Crack Sealant

The crack sealant shall be inspected for proper cure and set rating, bonding to the bituminous pavement, cohesive separation within the sealant, reversion to liquid, and entrapped air and voids. Sealants exhibiting any of these deficiencies at any time prior to the final acceptance of the project shall be removed from the crack, wasted, and replaced as specified herein at no additional cost to the Government.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-03150 (May 1998)**
U.S. ARMY CORPS OF ENGINEERS **----------------------**
Superseding
CEGS-03250 (July 1995)

GUIDE SPECIFICATION FOR CONSTRUCTION

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05/98

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DEPARTMENT OF THE ARMY **CEGS-03150 (May 1998)**
U.S. ARMY CORPS OF ENGINEERS **---------------------**
Superseding
CEGS-03250 (July 1995)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 03150

EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS
05/98

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NOTE: This guide specification covers the requirements for expansion joints, contraction joints and waterstops used in concrete construction. This guide will be used in conjunction with Section 03300, CAST-IN-PLACE STRUCTURAL CONCRETE.. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

(AASHTO)

AASHTO T 111	(1983) Inorganic Matter or Ash in Bituminous Materials

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA ANSI/AHA A135.4	(1995) Basic Hardboard

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 109	(1993) Steel, Strip, Carbon, Cold-Rolled
ASTM A 109M	(1991) Steel, Strip, Carbon, Cold-Rolled (Metric)
ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 480/A 480M	(1996a) General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A 570/A 570M	(1996) Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM B 152	(1994) Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B 152M	(1995) Copper Sheet, Strip, Plate, and Rolled Bar (Metric)
ASTM B 370	(1992) Copper Sheet and Strip for Building Construction
ASTM C 919	(1984; R 1992) Use of Sealants in Acoustical Applications
ASTM C 920	(1995) Elastomeric Joint Sealants
ASTM D 4	(1986; R 1993) Bitumen Content
ASTM D 6	(1995) Loss on Heating of Oil and Asphaltic Compounds
ASTM D 412	(1997) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 471	(1996) Rubber Property - Effect of Liquids
ASTM D 1190	(1996) Concrete Joint Sealer, Hot-Applied Elastic Type
ASTM D 1191	(1984; R 1994) Test Methods for Concrete Joint Sealers

ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 1854	(1996) Specification for Jet-Fuel-Resistant Concrete Joint Sealer, Hot-Poured Elastic Type
ASTM D 1855	(1989) Test Method for Jet-Fuel Resistant Concrete Joint Sealer, Hot-Applied Elastic Type
ASTM D 2628	(1991) Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D 2835	(1989; R 1993) Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
ASTM D 5249	(1995) Backer Material for Use With Cold and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints

CORPS OF ENGINEERS (COE)

COE CRD-C 513	(1974) Corps of Engineers Specifications for Rubber Waterstops
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Preformed Expansion Joint Filler; [_____]. Sealant; [_____]. Waterstops; [_____].

Manufacturer's literature, including safety data sheets, for preformed fillers and the lubricants used in their installation; field-molded sealants and primers (when required by sealant manufacturer); preformed compression seals; and waterstops.

SD-04 Drawings

Waterstops; [_____].

Shop drawings and fabrication drawings provided by the manufacturer or prepared by the Contractor.

SD-06 Instructions

Preformed Expansion Joint Filler; [_____]. Sealant; [_____]. Waterstops; [_____].

Manufacturer's recommended instructions for installing preformed fillers, field-molded sealants; preformed compression seals; and waterstops; and for splicing non-metallic waterstops.

SD-13 Certificates

Preformed Expansion Joint Filler; [_____]. Sealant; [_____]. Waterstops; [_____].

Certificates of compliance stating that the joint filler and sealant materials and waterstops conform to the requirements specified.

SD-14 Samples

Preformed Compression Seals and Lubricants; [_____].

Specimens identified to indicate the manufacturer, type of material, size and quantity of material, and shipment or lot represented. Each sample shall be a piece not less than 9 ft of 1 inch nominal width or wider seal or a piece not less than 12 ft of compression seal less than 1 inch nominal width. One quart of lubricant shall be provided.

Field-Molded Type; [_____].

One gallon of field-molded sealant and one quart of primer (when primer is recommended by the sealant manufacturer) identified to indicate manufacturer, type of material, quantity, and shipment or lot represented.

Non-metallic Materials; [_____].

Specimens identified to indicate manufacturer, type of material, size, quantity of material, and shipment or lot represented. Each sample shall be a piece not less than 12 inch long cut from each 200 ft of finished waterstop furnished, but not less than a total of 4 ft of each type, size, and lot furnished. One splice sample of each size and type for every 50 splices made in the factory and every 10 splices made at the job site. The splice samples shall be made using straight run pieces with the splice located at the mid-length of the sample and finished as required for the installed waterstop. The total length of each splice shall be not less than 12 inches long.

1.3 DELIVERY AND STORAGE

Material delivered and placed in storage shall be stored off the ground and protected from moisture, dirt, and other contaminants. Sealants shall be delivered in the manufacturer's original unopened containers. Sealants whose shelf life has expired shall be removed from the site.

PART 2 PRODUCTS

2.1 CONTRACTION JOINT STRIPS

Contraction joint strips shall be 1/8 inch thick tempered hardboard conforming to AHA ANSI/AHA A135.4, Class 1. In lieu of hardboard strips, rigid polyvinylchloride (PVC) or high impact polystyrene (HIPS) insert strips specifically designed to induce controlled cracking in slabs on grade may be used. Such insert strips shall have removable top section.

2.2 PREFORMED EXPANSION JOINT FILLER

Expansion joint filler shall be preformed material conforming to ASTM D 1751 or ASTM D 1752. Unless otherwise indicated, filler material shall be 3/8 inch thick and of a width applicable for the joint formed. Backer material, when required, shall conform to ASTM D 5249.

2.3 SEALANT

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NOTE: Types of joint material should be shown. Elastomeric joint seals (ASTM D 2628) will be used in compression type joints. For slabs receiving considerable fuel spillage, the hot-applied jet-fuel resistant type should be used when a thermoplastic elastomeric rubber (TPE-R) waterstop is not specified.

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Joint sealant shall conform to the following:

2.3.1 Preformed Polychloroprene Elastomeric Type

ASTM D 2628.

2.3.2 Lubricant for Preformed Compression Seals

ASTM D 2835.

2.3.3 Hot-Poured Type

ASTM D 1190 tested in accordance with ASTM D 1191.

2.3.4 Field Molded Type

ASTM C 920, Type M for horizontal joints or Type NS for vertical joints, Class 25, and Use NT. Bond breaker material shall be polyethylene tape, coated paper, metal foil or similar type materials. The back-up material shall be compressible, non-shrink, nonreactive with sealant, and non-absorptive material type such as extruded butyl or polychloroprene rubber.

2.3.5 Hot-Applied Jet-Fuel Resistant Type

ASTM D 1854 tested in accordance with ASTM D 1855.

2.4 WATERSTOPS

Intersection and change of direction waterstops shall be shop fabricated.

2.4.1 Flexible Metal

Copper waterstops shall conform to ASTM B 152 and ASTM B 370, O60 soft anneal temper and 20 oz mass per sq ft sheet thickness. Stainless steel waterstops shall conform to ASTM A 167 and ASTM A 480/A 480M, UNS S30453 (Type 304L), and 20 gauge thick strip.

2.4.2 Rigid Metal

Flat steel waterstops shall conform to ASTM A 109, No. 2 (half hard) temper, No. 2 edge, No. 1 (matte or dull) finish or ASTM A 570/A 570M, Grade 40.

2.4.3 Non-Metallic Materials`

Non-metallic waterstops shall be manufactured from a prime virgin resin; reclaimed material is not acceptable. The compound shall contain plasticizers, stabilizers, and other additives to meet specified requirements. Rubber waterstops shall conform to COE CRD-C 513. Polyvinylchloride waterstops shall conform to COE CRD-C 572. Thermoplastic elastomeric rubber waterstops shall conform to ASTM D 471.

2.4.4 Non-Metallic Hydrophilic

Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water shall conform to ASTM D 412 as follows: Tensile strength 420 psi minimum; ultimate elongation 600 percent minimum. Hardness shall be 50 minimum on the type A durometer and the volumetric expansion ratio in distilled water at 70 degrees F shall be 3 to 1 minimum.

2.4.5 Preformed Elastic Adhesive

Preformed plastic adhesive waterstops shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler, and shall contain no solvents, asbestos, irritating fumes or obnoxious odors. The compound shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength.

2.4.5.1 Chemical Composition

The chemical composition of the sealing compound shall meet the requirements shown below:

PERCENT BY WEIGHT

COMPONENT	MIN.	MAX.	TEST
Bitumen (Hydrocarbon plastic)	50	70	ASTM D 4
Inert Mineral Filler	30	50	AASHTO T 111
Volatile Matter		2	ASTM D 6

2.4.5.2 Adhesion Under Hydrostatic Pressure

The sealing compound shall not leak at the joints for a period of 24 hours under a vertical 6 foot head pressure. In a separate test, the sealing compound shall not leak under a horizontal pressure of 10 psi which is reached by slowly applying increments of 2 psi every minute.

2.4.5.3 Sag of Flow Resistance

Sagging shall not be detected when tested as follows: Fill a wooden form 1 inch wide and 6 inches long flush with sealing compound and place in an oven at 135 degrees F in a vertical position for 5 days.

2.4.5.4 Chemical Resistance

The sealing compound when immersed separately in a 5% solution of caustic potash, a 5% solution of hydrochloric acid, 5% solution of sulfuric acid and a saturated hydrogen sulfide solution for 30 days at ambient room temperature shall show no visible deterioration.

PART 3 EXECUTION

3.1 JOINTS

Joints shall be installed at locations indicated and as authorized.

3.1.1 Contraction Joints

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NOTE: Since contraction joint strips are difficult to align and maintain in alignment, the option for use of joint strips should be deleted where appearance is important or where concrete slabs will not be covered with subsequent toppings that will hide the joint.

****

Contraction joints may be constructed by inserting tempered hardboard strips or rigid PVC or HIPS insert strips into the plastic concrete using a steel parting bar, when necessary, or by cutting the concrete with a saw after concrete has set. Joints shall be approximately 1/8 inch wide and shall extend into the slab one-fourth the slab thickness, minimum, but not less than 1 inch.

3.1.1.1 Joint Strips

Strips shall be of the required dimensions and as long as practicable. After the first floating, the concrete shall be grooved with a tool at the joint locations. The strips shall be inserted in the groove and depressed until the top edge of the vertical surface is flush with the surface of the slab. The slab shall be floated and finished as specified. Working of the concrete adjacent to the joint shall be the minimum necessary to fill voids and consolidate the concrete. Where indicated, the top portion of the strip shall be sawed out after the curing period to form a recess for sealer. The removable section of PVC or HIPS strips shall be discarded and the insert left in place. True alignment of the strips shall be maintained during insertion.

3.1.1.2 Sawed Joints

Joint sawing shall be early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling. Concrete sawing machines shall be adequate in number and power, and with sufficient replacement blades to complete the sawing at the required rate. Joints shall be cut to true alignment and shall be cut in sequence of concrete placement. Sludge and cutting debris shall be removed.

3.1.2 Expansion Joints

Preformed expansion joint filler shall be used in expansion and isolation joints in slabs around columns and between slabs on grade and vertical surfaces where indicated. The filler shall extend the full slab depth, unless otherwise indicated. The edges of the joint shall be neatly finished with an edging tool of 1/8 inch radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, the filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed and oiled wood strip temporarily secured to the top to form a recess to the size shown on the drawings. The wood strip shall be removed after the concrete has set. Contractor may opt to use a removable expansion filler cap designed and fabricated for this purpose in lieu of the wood strip. The groove shall be thoroughly cleaned of laitance, curing compound, foreign materials, protrusions of hardened concrete, and any dust which shall be blown out of the groove with oil-free compressed air.

3.1.3 Joint Sealant

Sawed contraction joints and expansion joints in slabs shall be filled with joint sealant, unless otherwise shown. Joint surfaces shall be clean, dry, and free of oil or other foreign material which would adversely affect the bond between sealant and concrete. Joint sealant shall be applied as recommended by the manufacturer of the sealant.

3.1.3.1 Joints With Preformed Compression Seals

Compression seals shall be installed with equipment capable of installing joint seals to the prescribed depth without cutting, nicking, twisting, or otherwise distorting or damaging the seal or concrete and with no more than 5 percent stretching of the seal. The sides of the joint and, if necessary, the sides of the compression seal shall be covered with a coating of lubricant. Butt joints shall be coated with liberal applications of lubricant.

3.1.3.2 Joints With Field-Molded Sealant

Joints shall not be sealed when the sealant material, ambient air, or concrete temperature is less than 40 degrees F. When the sealants are meant to reduce the sound transmission characteristics of interior walls, ceilings, and floors the guidance provided in ASTM C 919 shall be followed.

Joints requiring a bond breaker shall be coated with curing compound or with bituminous paint. Bond breaker and back-up material shall be installed where required. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations.

3.2 WATERSTOPS, INSTALLATION AND SPLICES

Waterstops shall be installed at the locations shown to form a continuous water-tight diaphragm. Adequate provision shall be made to support and completely protect the waterstops during the progress of the work. Any waterstop punctured or damaged shall be repaired or replaced. Exposed waterstops shall be protected during application of form release agents to avoid being coated. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued. Splices shall be made by certified trained personnel using approved equipment and procedures.

3.2.1 Copper And Stainless Steel

Splices in copper waterstops shall be lap joints made by brazing. Splices in stainless steel waterstops shall be welded using a TIG or MIG process utilizing a weld rod to match the stainless. All welds shall not be annealed to maintain physical properties. Carbon flame shall not be used in the annealing process. Damaged waterstops shall be repaired by removing damaged portions and patching. Patches shall overlap a minimum of 1 inch onto undamaged portion of the waterstop.

3.2.2 Flat Steel

Splices in flat steel waterstops shall be properly aligned, butt welded, and cleaned of excessive material.

3.2.3 Non-Metallic

Fittings shall be shop made using a machine specifically designed to mechanically weld the waterstop. A miter guide, proper fixturing (profile dependant), and portable power saw shall be used to miter cut the ends to be joined to ensure good alignment and contact between joined surfaces. The splicing of straight lengths shall be done by squaring the ends to be joined. Continuity of the characteristic features of the cross section of the waterstop (ribs, tabular center axis, protrusions, etc.) shall be maintained across the splice.

3.2.3.1 Rubber Waterstop

Splices shall be vulcanized or shall be made using cold bond adhesive as recommended by the manufacturer. Splices for TPE-R shall be as specified for PVC.

3.2.3.2 Polyvinyl Chloride Waterstop

Splices shall be made by heat sealing the adjacent waterstop edges together using a thermoplastic splicing iron utilizing a non-stick surface specifically designed for waterstop welding. The correct temperature shall be used to sufficiently melt without charring the plastic. The spliced area, when cooled, shall show no signs of separation, holes, or other imperfections when bent by hand in as sharp an angle as possible.

3.2.3.3 Quality Assurance

Edge welding will not be permitted. Centerbulbs shall be compressed or closed when welding to non-centerbulb type. Waterstop splicing defects which are unacceptable include, but are not limited to the following: 1) Tensile strength less than 80 percent of parent section. 2) Free lap joints. 3) Misalignment of centerbulb, ribs, and end bulbs greater than 1/16 inch. 4) Misalignment which reduces waterstop cross section more than 15 percent. 5) Bond failure at joint deeper than 1/16 inch or 15 percent of material thickness. 6) Misalignment of waterstop splice resulting in misalignment of waterstop in excess of 1/2 inch in 10 feet. 7) Visible porosity in the weld area, including pin holes. 8) Charred or burnt material. 9) Bubbles or inadequate bonding. 10) Visible signs of splice separation when cooled splice is bent by hand at a sharp angle.

3.2.4 Non-Metallic Hydrophilic Waterstop Installation

Ends to be joined shall be miter cut with sharp knife or shears. The ends shall be adhered with cyanacryiate (super glue) adhesive. When joining hydrophilic type waterstop to PVC waterstop, the hydrophilic waterstop shall be positioned as shown on the drawings. A liberal amount of a single component hydrophilic sealant shall be applied to the junction to complete the transition.

3.2.5 Preformed Plastic Adhesive Installation

The installation of preformed plastic adhesive waterstops shall be a prime, peel, place and pour procedure. Joint surfaces shall be clean and dry before priming and just prior to placing the sealing strips. The end of each strip shall be spliced to the next strip with a 1 inch overlap; the overlap shall be pressed firmly to release trapped air. During damp or cold conditions the joint surface shall be flashed with a safe, direct flame to warm and dry the surface adequately; the sealing strips shall be dipped in warm water to soften the material to achieve maximum bond to the concrete surface.

3.3 CONSTRUCTION JOINTS

Construction joints are specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE except that construction joints coinciding with expansion and contraction joints shall be treated as expansion or contraction joints as applicable.

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-03200 (September 1997)**
U.S. ARMY CORPS OF ENGINEERS | **---------------------------**
Superseding
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GUIDE SPECIFICATION FOR CONSTRUCTION

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DIVISION 03 - CONCRETE

SECTION 03200

CONCRETE REINFORCEMENT

09/97

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-- End of Section Table of Contents --

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DEPARTMENT OF THE ARMY | **CEGS-03200 (September 1997)**
U.S. ARMY CORPS OF ENGINEERS | **---------------------------**
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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 03200

CONCRETE REINFORCEMENT
09/97

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NOTE: This specification covers the requirements for concrete reinforcement, including welded wire fabric, for building construction in conjunction with Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 318/318R	(1995) Building Code Requirements for Structural Concrete and Commentary
ACI 318M	(1995) Building Code Requirements for Structural Concrete and Commentary (Metric)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 82	(1995a) Steel Wire, Plain, for Concrete Reinforcement
ASTM A 184/A 184M	(1996) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 185	(1994) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 496	(1995a) Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497	(1995) Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A 615/A 615M	(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 675/A 675M	(1990a; R 1995) Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASTM A 706/A 706M	(1995b) Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 767/A 767M	(1995) Zinc-Coated (Galvanized) Steel Bars in Concrete Reinforcement
ASTM A 775/A 775M	(1996) Epoxy-Coated Reinforcement Steel Bars
ASTM A 884/A 884M	(1996a) Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement
ASTM C 1116	(1995) Fiber-Reinforced Concrete and Shotcrete

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4	(1992) Structural Welding Code - Reinforcing Steel

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI MSP-1	(1996) Manual of Standard Practice

1.2 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Concrete Reinforcement System; [_____].

Detail drawings showing reinforcing steel placement, schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

SD-08 Statements

Welding; [_____].

A list of qualified welders names.

SD-13 Certificates

Reinforcing Steel; [_____].

Certified copies of mill reports attesting that the reinforcing steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified herein, prior to the installation of reinforcing steel.

1.3 WELDING

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NOTE: Delete this paragraph and submittal requirement under SD-08 when welding is not permitted. Welding will not be specified in blast-resistant structures.
****

Welders shall be qualified in accordance with AWS D1.4. Qualification test shall be performed at the worksite and the Contractor shall notify the Contracting Officer 24 hours prior to conducting tests. Special welding procedures and welders qualified by others may be accepted as permitted by AWS D1.4.

1.4 DELIVERY AND STORAGE

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

PART 2 PRODUCTS

****

NOTE: Designer should require materials, products, and innovative construction methods and techniques which are environmentally sensitive, take advantage or recycling and conserve natural resources.

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2.1 DOWELS

Dowels shall conform to ASTM A 675/A 675M, Grade 80. Steel pipe conforming to ASTM A 53, Schedule 80, may be used as dowels provided the ends are closed with metal or plastic inserts or with mortar.

2.2 FABRICATED BAR MATS

Fabricated bar mats shall conform to ASTM A 184/A 184M.

2.3 REINFORCING STEEL

****

NOTE: Grades and sizes of reinforcing steel will be shown on the drawings. Low-alloy steel conforming to ASTM A 706/A 706M is specified for its special qualities such as bending ability and ease of welding.

Specially coated bars (epoxy and zinc) may be specified for use in a highly corrosive atmosphere where concrete cover is not considered sufficient.

Certified mill reports should be obtained when welding is specified or permitted. On minor projects with no welding, submittal SD-13 may be deleted.

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Reinforcing steel shall be deformed bars conforming to ASTM A 615/A 615M or ASTM A 706/A 706M, grades and sizes as indicated. Cold drawn wire used for spiral reinforcement shall conform to ASTM A 82. In highly corrosive environments or when directed by the Contracting Officer, reinforcing steel shall conform to ASTM A 767/A 767M or ASTM A 775/A 775M as appropriate.

2.4 WELDED WIRE FABRIC

Welded wire fabric shall conform to [ASTM A 185] [ASTM A 496] [ASTM A 497]. When directed by the Contracting Officer for special applications, welded wire fabric shall conform to ASTM A 884/A 884M.

2.5 WIRE TIES

Wire ties shall be 16 gauge or heavier black annealed steel wire.

2.6 SUPPORTS

Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI MSP-1 and shall be steel or precast concrete blocks. Precast concrete blocks shall have wire ties and shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within 1/2 inch of concrete surface shall be galvanized, plastic protected or of stainless steel. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.

2.7 SYNTHETIC FIBER REINFORCEMENT

Synthetic fiber shall be polypropylene with a denier less than 100 and a nominal fiber length of 2 inches.

PART 3 EXECUTION

3.1 REINFORCEMENT

****

NOTE: There may be special cases where reinforcing bars, at determined intervals, will be added across expansion, isolation or construction joints to provide continuity of reinforcement in meeting lightning protection criteria. The structural designer should coordinate this requirement with the electrical designer to minimize reinforcement across the joints.

****

Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318/318R. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety. Wire tie ends shall face away from the forms.

3.1.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete. Reinforcement shall be placed in accordance with ACI 318/318R at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318/318R. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

3.1.2 Splicing

****
NOTE: Edit this paragraph to remove welding requirements when welding is not permitted. The only type of connection allowed in blast resistant structures is Cadweld or lapping of rebars.
****

Splices of reinforcement shall conform to ACI 318/318R and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical or welded butt connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Welding shall conform to AWS D1.4. Welded butt splices shall be full penetration butt welds. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6 inches. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

3.2 WELDED-WIRE FABRIC PLACEMENT

Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Fabric placement at joints shall be as indicated. Lap splices shall be made in such a way that the overlapped area equals the distance between the outermost crosswires plus 2 inches. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 4 feet. Fabric shall be positioned by the use of supports.

3.3 DOWEL INSTALLATION

Dowels shall be installed in slabs on grade at locations indicated and at right angles to joint being doweled. Dowels shall be accurately positioned and aligned parallel to the finished concrete surface before concrete placement. Dowels shall be rigidly supported during concrete placement. One end of dowels shall be coated with a bond breaker.

3.4 SYNTHETIC FIBER REINFORCED CONCRETE

****
NOTE: Synthetic fiber reinforcement may be used in concrete slabs as an aid in preventing plastic or shrinkage cracking in placements susceptible to this condition. Fiber reinforcement will not be used as a substitute for wire mesh and where service temperature may exceed 150 degrees C (300 degrees F). Concentrations above 0.1 percent by volume are not cost-effective.
****

Fiber reinforcement shall be added to the concrete mix in accordance with the applicable sections of ASTM C 1116 and the recommendations of the manufacturer, and in an amount of [0.1] [_____] percent by volume.

-- End of Section --

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SECTION 03300

CAST-IN-PLACE STRUCTURAL CONCRETE
09/95

****
NOTE: This guide specification covers the requirements for cast-in-place concrete materials, mixing, placement, and finishes. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for unit price contract, lump sum contract, field test panels, mix design by Contractor, chemical admixtures, synthetic fiber reinforcing, dry shake topping, finishing formed surfaces, and finishing unformed surfaces. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.
****

PART 1 GENERAL

****
NOTE: This specification covers concrete work primarily for buildings, but may also be used for other applications such as wharves, docks, drainage structures, warehouse type slabs, and driveways. The following guide specifications are relative to this section and will be included to the extent applicable in projects where this section is used:

Section 03100 STRUCTURAL CONCRETE FORMWORK
Section 03200 CONCRETE REINFORCEMENT
Section 03150 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS
Section 07900 JOINT SEALING

Specifications on concrete for bridge construction should be in a separate section and should be essentially in agreement with concrete construction requirements in the American Association of State Highway and Transportation Officials, "Standard Specifications for Highway Bridges." Requirements for deck slabs, curbs, gutters, and sidewalks forming an integral part of the bridge should be included in the section concerning concrete for bridge construction.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 117/117R	(1990; Errata) Standard Tolerances for Concrete Construction and Materials
ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 211.2	(1998) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 213R	(1987) Guide for Structural Lightweight Aggregate Concrete

ACI 214.3R	(1988) Simplified Version of the Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 301	(1996) Standard Specifications for Structural Concrete
ACI 303R	(1991) Guide to Cast-In-Place Architectural Concrete Practice
ACI 305R	(1991) Hot Weather Concreting
ACI 318/318R	(1995) Building Code Requirements for Reinforced Concrete and Commentary

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(1991) Burlap Cloth Made From Jute or Kenaf

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31/C 31M	(1996) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1997) Concrete Aggregates
ASTM C 39	(1996) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42	(1994) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 78	(1994) Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
ASTM C 94	(1997) Ready-Mixed Concrete
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 150	(1997) Portland Cement
ASTM C 171	(1997) Sheet Materials for Curing Concrete
ASTM C 172	(1997) Sampling Freshly Mixed Concrete
ASTM C 173	(1996) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192/C 192M	(1995) Making and Curing Concrete Test

	Specimens in the Laboratory
ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1995) Air-Entraining Admixtures for Concrete
ASTM C 309	(1997) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 330	(1989) Lightweight Aggregates for Structural Concrete
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 496	(1996) Splitting Tensile Strength of Cylindrical Concrete Specimens
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 567	(1991) Unit Weight of Structural Lightweight Concrete
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 595	(1995a) Blended Hydraulic Cements
ASTM C 618	(1997) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 685	(1995a) Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C 881	(1990) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 937	(1980; R 1991) Grout Fluidifier for Preplaced-Aggregate Concrete
ASTM C 940	(1989) Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C 989	(1997) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1017	(1992) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1059	(1991) Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C 1064	(1986; R 1993) Temperature of Freshly

	Mixed Portland Cement Concrete
ASTM C 1077	(1997) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1107	(1997) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1116	(1995) Fiber-Reinforced Concrete and Shotcrete
ASTM C 1240	(1997) Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar and Grout
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM E 1155	(1996) Determining Floor Flatness and Levelness Using the F-Number System

CORPS OF ENGINEERS (COE)

COE CRD-C 94	(1995) Surface Retarders
COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
COE CRD-C 540	(1971; R 1981) Standard Specification for Nonbituminous Inserts for Contraction Joints in Portland Cement Concrete Airfield Pavements, Sawable Type
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(1997) NIST Handbook 44: Specifications, Tolerances, and Other Technical

	Requirements for Weighing and Measuring Devices

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(1990) Concrete Plant Standards
NRMCA TMMB 100	(1994) Truck Mixer Agitator and Front Discharge Concrete Carrier Standards
NRMCA QC 3	(1984) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

1.2 UNIT PRICE CONTRACT

****
NOTE: Remove these paragraphs when lump sum contract is required.
****

1.2.1 Measurement

Measurement of concrete for payment will be made on the basis of the actual volume within the pay lines of the structure as indicated on the contract drawings. Measurement for payment of concrete placed against the sides of any excavation without intervening forms will be made only within the pay lines of the structure as shown on the contract drawings. No deductions will be made for rounded or beveled edges, for space occupied by metal work, for conduits, for voids, or for embedded items which are less than 5 cubic feet in volume or 1 square foot in cross section.

1.2.2 Payment

Unless otherwise specified, payment for concrete will be made at the respective unit prices per cubic yard for the various items of the schedule, measured as specified above, which price shall include the cost of all labor, materials, and the use of equipment and tools required to complete the concrete work, except for any reinforcement and embedded parts specified to be paid separately. Unit price payment will not be made for concrete placed in structures for which payment is made as a lump sum.

1.3 LUMP SUM CONTRACT

****
NOTE: Remove this paragraph when unit price contract is required.
****

Under this type of contract concrete items will be paid for by lump sum and will not be measured. The work covered by these items consists of furnishing all concrete materials, reinforcement, miscellaneous embedded materials, and equipment, and performing all labor for the forming, manufacture, transporting, placing, finishing, curing, and protection of concrete in these structures.

1.4 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Mixture Proportions; GA.

The results of trial mixture design studies along with a statement giving the maximum nominal coarse aggregate size and the proportions of ingredients that will be used in the manufacture of each strength or class of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an approved independent commercial testing laboratory, showing that mixture design studies have been made with materials proposed for the project and that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the mixture design studies without additional tests to show that the quality of the concrete is satisfactory.

Lightweight Aggregate Concrete; [_____].

Written recommendations from lightweight aggregate supplier on batching and mixing cycles.

Dry Shake Finish; [_____].

Manufacturer's written instructions on application of dry shake material 15 days prior to start of construction.

SD-09 Reports

Testing and Inspection for Contractor Quality Control; GA.

Certified copies of laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolan, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.

SD-13 Certificates

Qualifications; [_____].

Written documentation for Contractor Quality Control personnel.

SD-14 Samples

Surface Retarder; [_____].

Surface retarder material with manufacturer's instructions for application in conjunction with air-water cutting.

1.5 QUALIFICATIONS

Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) Certified Workmen in one of the following grades or shall have written evidence of having completed similar qualification programs:

Concrete Field Testing Technician, Grade I
Concrete Laboratory Testing Technician, Grade I or II
Concrete Construction Inspector, Level II

Concrete Transportation Construction Inspector or
Reinforced Concrete Special Inspector, Jointly certified by American Concrete Institute (ACI), Building Official and Code Administrators International (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International (SBCCI).

The foreman or lead journeyman of the flatwork finishing crew shall have similar qualification for ACI Concrete Flatwork Technician/Finisher or equal, with written documentation.

1.6 FIELD TEST PANELS

****

NOTE: Edit these paragraphs as appropriate. Specify location for all field test panels. Add requirements for mock-ups if applicable. Add requirements for slab panels if exposed aggregate slab finish is required or if superflat slab finish is required.

****

Field test panels shall be constructed prior to beginning of work using the materials and procedures proposed for use on the job, to demonstrate the results to be attained. The quality and appearance of each panel shall be subject to the approval of the Contracting Officer, and, if not judged satisfactory, additional panels shall be constructed until approval is attained. Formed or finished surfaces in the completed structure shall match the quality and appearance of the approved field example.

1.6.1 Sample Wall Panels

One sample panel at least 4 feet by 5 feetand 6 inches thick shall be constructed to demonstrate Class A formed finish and a similar one for Class B formed finish. Panels shall be located [_____]. Each panel shall include a full length and full width joint line and shall have at least two voids each at least 12 inches by 12 inches by 3 inches deep either impressed in the concrete as placed or chipped in the hardened concrete.

After the concrete is 7 days old, the voids shall be patched to demonstrate the effectiveness and the appearance of the Contractor's repair procedures.

1.6.2 Slab Panels

A slab panel at least 4 feet by 5 feet and 4 inches thick shall be constructed to demonstrate exposed aggregate slab finish and a similar panel for extra high class slab finish. Panels shall be located [_____]. Each panel shall have a full length joint line.

1.7 SPECIAL REQUIREMENTS

****

NOTE: When the construction includes special items such as very high strength concrete; non-sparking, conductive flooring; acid-resistant concrete; slipforming; super-flat floors; etc., a pre-installation meeting will be required. In which case this paragraph will be retained with appropriate editing and identification.

****

A pre-installation meeting with the Contracting Officer will be required at least 10 days prior to start of construction on [_____]. The Contractor shall be responsible for calling the meeting; the Project Superintendent and active installation personnel shall be present.

1.8 GENERAL REQUIREMENTS

****

NOTE: In addition to specified requirements the following information will be shown on project drawings:

1. Assumed temperature range when temperature stresses are a factor in design.

2. Details of concrete sections showing dimensions, reinforcement cover, and required camber.

3. Joint details showing locations and dimensions, including critical construction joints, indicating waterstop locations and splices, keys, and dowels when required.

4. Locations where structural lightweight concrete will be used.

5. Details which require a depressed structural slab for tile, terrazzo, or other floor finishes in order to provide finished surfaces at the same elevations.

6. When exposed concrete surfaces are specified, the locations in the finished structure shall be indicated. If other than cast finish is required,

the type and location shall be indicated.

7. Loading assumptions

8. Material strengths used in design, and f'c.
****

1.8.1 Tolerances

****
NOTE: Insert any special tolerance requirements of the project. Select the method desired for floor finish tolerance and delete the other. Do not use both as a Contractor's option. An effort should be made to begin to convert to the F-system for floor slabs. The F-system should always be used where very flat floors are required, particularly warehouse aisles where high-lift forklift units or other similar stackers will operate.
****

Except as otherwise specified herein, tolerances for concrete batching, mixture properties, and construction as well as definition of terms and application practices shall be in accordance with ACI 117/117R. Level and grade tolerance measurements of slabs shall be made as soon as possible after finishing; when forms or shoring are used, the measurements shall be made prior to removal.

1.8.1.1 Floors

For the purpose of this Section the following terminology correlation between ACI 117/117R and this Section shall apply:

Floor Profile Quality Classification From ACI 117/117R	This Section
Conventional Bullfloated	Same
Conventional Straightedged	Same
Flat	Float Finish or Trowel Finish
Very Flat	Same. Use only with F-system

Levelness tolerance shall not apply where design requires floors to be sloped to drains or sloped for other reasons.

1.8.1.2 Floors by the F-Number System

The flatness and levelness of floors shall be carefully controlled and the tolerances shall be measured by the F-Number system of Paragraph 4.5.6 and 4.5.6.1 of ACI 117/117R. The Contractor shall furnish an approved floor profilograph or other equipment capable of measuring the floor flatness (FF) number and the floor levelness (FL) number in accordance with ASTM E 1155. The Contractor shall perform the tolerance measurements within 72 hours after floor slab construction while being observed by the Contracting Officer. The tolerances of surfaces beyond the limits of ASTM E 1155 (the areas within 24 inches of embedments and construction joints) shall be acceptable to the Contracting Officer. Tolerances of the following areas shall meet the requirements for the listed surfaces as specified in paragraphs 4.5.6 and 4.5.6.1 of ACI 117/117R.

Bullfloated-	Areas [_____]
Straightedged-	Areas [_____]
Float Finish-	Areas [_____]
Trowel Finish-	Areas [_____]
Very Flat-	Areas [_____]

1.8.1.3 Floors by the Straightedge System

The flatness of the floors shall be carefully controlled and the tolerances shall be measured by the straightedge system as specified in paragraph 4.5.7 of ACI 117/117R, using a 10 foot straightedge, within 72 hours after floor slab installation and before shores and/or forms are removed. The listed tolerances shall be met at any and every location at which the straightedge can be placed.

Bullfloated	[_____]
Straightedged	[_____]
Float Finish	[_____]
Trowel Finish	[_____]

1.8.2 Strength Requirements and w/c Ratio

1.8.2.1 Strength Requirements

****

NOTE: The designer will list the strengths of concrete for the job and the uses for each. A 28-day compressive strength of 20 MPa (3000 psi) will be required for most building work. Concrete of 27.5 MPa (4000 psi) should be used in containers for liquids, and in other structures where loading, durability, or wear requirements dictate. Higher compressive strengths will be used if required by structural design. A 28-day flexural strength of 4.5 MPa (650 psi) will normally be specified for slabs on grade subject to vehicular traffic; however, since cylinders are easier to cast and test than beams, 27.5 MPa (4000 psi) compressive strength concrete may be specified if past experience has shown this to be appropriate. Concrete for hangar floors will be designed according to airfield pavement criteria and will be specified in Section 02513 CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER HEAVY-DUTY PAVEMENTS.

When the designer considers it appropriate, 90-day compressive or flexural strength may be specified in lieu of 28-day, but not both.

****

Specified compressive strength (f'c) shall be as follows:

COMPRESSIVE STRENGTH	STRUCTURE OR PORTION OF STRUCTURE
[5000 psi at 28 days	[_____]]

COMPRESSIVE STRENGTH	STRUCTURE OR PORTION OF STRUCTURE
[4000 psi at 28 days	[_____]]
[3000 psi at 28 days	[_____]]
[[_____] psi at [_____] days	[_____]]

Concrete slabs on-grade shall have a 28-day flexural strength of [650] [_____] psi. Concrete made with high-early strength cement shall have a 7-day strength equal to the specified 28-day strength for concrete made with Type I or II portland cement. Compressive strength shall be determined in accordance with ASTM C 39. Flexural strength shall be determined in accordance with ASTM C 78.

a. Evaluation of Concrete Compressive Strength. Compressive strength specimens (6 by 12 inch cylinders) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified compressive strength f'c and no individual test result falls below the specified strength f'c by more than 500 psi. A "test" is defined as the average of two companion cylinders, or if only one cylinder is tested, the results of the single cylinder test. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.

b. Investigation of Low-Strength Compressive Test Results. When any strength test of standard-cured test cylinders falls below the specified strength requirement by more than 500 psi or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. When the strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores will be determined by the Contracting Officer to least impair the strength of the structure. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. Non-destructive tests (tests other than test cylinders or cores) shall not be used as a basis for acceptance or rejection. The Contractor shall perform the coring and repair the holes. Cores will be tested by the Government.

c. Load Tests. If the core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318/318R. Concrete work evaluated by structural analysis or by results of a load test as being understrength shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed by and at the expense of the Contractor and must be approved by the Contracting Officer, except that if all concrete is found to be in compliance with the drawings and specifications, the cost of investigations, testing, and load tests will be at the expense of the Government.

d. Evaluation of Concrete Flexural Strength. Flexural strength specimens (beams) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 78. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified flexural strength and no individual test result falls below the specified flexural strength by more than 50 psi.A "test" is defined as the average of two companion beams. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the slab is considered potentially deficient.

1.8.2.2 Water-Cement Ratio

****
NOTE: Where durability or other factors are a major consideration, add this paragraph limiting w/c, otherwise delete. When cementitious materials other than portland cement are used, retain the last two sentences. Consult EM 1110-2-2000 to fill in the blanks and to select the appropriate w/c.
****

Maximum water-cement ratio (w/c) for normal weight concrete shall be as follows:

WATER-CEMENT RATIO, BY WEIGHT	STRUCTURE OR PORTION OF STRUCTURE
[0.40]	[_____]
[0.45]	[_____]
[0.50]	[_____]
[0.55]	[_____]
[_____]	[_____]

These w/c's may cause higher strengths than that required above for compressive or flexural strength. The maximum w/c required will be the equivalent w/c as determined by conversion from the weight ratio of water to cement plus pozzolan, silica fume, and ground granulated blast furnace slag (GGBF slag) by the weight equivalency method as described in ACI 211.1. In the case where silica fume or GGBF slag is used, the weight of the silica fume and GGBF slag shall be included in the equations of ACI 211.1 for the term P which is used to denote the weight of pozzolan.

1.8.3 Air Entrainment

****
NOTE: Remove last two sentences when lightweight concrete is not required.
****

Except as otherwise specified for lightweight concrete, all normal weight concrete shall be air entrained to contain between 4 and 7 percent total air, except that when the nominal maximum size coarse aggregate is 3/4 inch or smaller it shall be between 4.5 and 7.5 percent. Concrete with specified strength over 5000 psi may have 1.0 percent less air than specified above. Specified air content shall be attained at point of placement into the forms. Air content for normal weight concrete shall be determined in accordance with ASTM C 231. Lightweight concrete in the [_____] parts of the structure shall be air-entrained with a total air content of 4.5 to 7.5 percent, except that if the nominal maximum size coarse aggregate is 3/8 inch or less, the air content shall be 5.5 to 8.5 percent. Air content for lightweight concrete shall be determined in accordance with ASTM C 173.

1.8.4 Slump

****
NOTE: Use the sentence in the first set of brackets when those admixtures are permitted by the specifications. Add special slump requirements for Class 8 and 9 floor slabs from ACI 302, when such floors are to be constructed. Edit for lightweight concrete as required.
****

Slump of the concrete, as delivered to the point of placement into the forms, shall be within the following limits. Slump shall be determined in accordance with ASTM C 143.

Structural Element	Slump Minimum	Slump Maximum
Walls, columns and beams	2 in.	4 in.
Foundation walls, substructure walls, footings, slabs	1 in.	3 in.
Any structural concrete approved for placement by pumping:		
At pump	2 in.	6 in.
At discharge of line	1 in.	4 in.

[When use of a plasticizing admixture conforming to ASTM C 1017 or when a Type F or G high range water reducing admixture conforming to ASTM C 494 is permitted to increase the slump of concrete, concrete shall have a slump of 2 to 4 inches before the admixture is added and a maximum slump of 8 inches at the point of delivery after the admixture is added.] [For troweled floors, slump of structural lightweight concrete with normal weight sand placed by pump shall not exceed 5 inches at the point of placement. For other slabs, slump of lightweight concrete shall not exceed 4 inches at point of placement.]

1.8.5 Concrete Temperature

The temperature of the concrete as delivered shall not exceed 90 degrees F. When the ambient temperature during placing is 40 degrees F or less, or is expected to be at any time within 6 hours after placing, the temperature of the concrete as delivered shall be between 55 and 75 degrees F.

1.8.6 Size of Coarse Aggregate

The largest feasible nominal maximum size aggregate (NMSA) specified in paragraph AGGREGATES shall be used in each placement. However, nominal maximum size of aggregate shall not exceed any of the following: three-fourths of the minimum cover for reinforcing bars, three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.

1.8.7 Special Properties and Products

****
NOTE: If the use of a particular type of admixture is required for certain parts of the structure, this paragraph should be revised accordingly.
****

Concrete may contain admixtures other than air entraining agents, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if specified or approved. Any of these materials to be used on the project shall be used in the mix design studies.

1.8.8 Lightweight Aggregate Structural Concrete

****
NOTE: Retain this paragraph when lightweight aggregate structural concrete is required. Use bracketed alternate strength inserts (compressive or splitting tensile strength) as appropriate. Correlate strength versus unit weight requirements as determined from table in ASTM C 330, and as determined by consultation with local producers. Remove last sentence when floor fill is not required.
****

Lightweight aggregate structural concrete shall conform to the requirements specified for normal weight concrete except as specified herein. [Specified compressive strength shall be at least [_____] at 28 days,] [Specified splitting tensile strength determined in accordance with ASTM C 496 shall be at least [_____] at 28 days,] as determined by test specimens that have been air dried at 50 percent relative humidity for the last 21 days. Air-dry unit weight shall be not over [_____] at 28 days as determined by ASTM C 567. However, fresh unit weight shall be used for acceptance during concreting, using a correlation factor between the two types of unit weight as determined during mixture design studies. Lightweight aggregate structural concrete floor fill shall have a 28-day compressive strength of at least 2500 psi and an air-dry unit weight not exceeding 115 pcf.

1.8.9 Technical Service for Specialized Concrete

****
NOTE: Use this paragraph when lightweight aggregate structural concrete is specified or for other specialized concretes like those containing silica fume.
****

The services of a factory trained technical representative shall be obtained to oversee proportioning, batching, mixing, placing, consolidating, and finishing of specialized structural concrete, such as [_____]. The technical representative shall be on the job full time until the Contracting Officer is satisfied that field controls indicate concrete of specified quality is furnished and that the Contractor's crews are capable of continued satisfactory work. The technical representative shall be available for consultation with, and advice to, Government forces.

1.9 MIXTURE PROPORTIONS

****

NOTE: This paragraph places the responsibility for mixture proportioning on the Contractor. Where Government mix design is required, the entire paragraph will be revised accordingly. Do not delete 15 percent minimum for pozzolan, unless pozzolan is prohibited.

****

Concrete shall be composed of portland cement, other cementitious and pozzolanic materials as specified, aggregates, water and admixtures as specified.

1.9.1 Proportioning Studies for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified shall be the responsibility of the Contractor. Except as specified for flexural strength concrete, mixture proportions shall be based on compressive strength as determined by test specimens fabricated in accordance with ASTM C 192/C 192M and tested in accordance with ASTM C 39. Samples of all materials used in mixture proportioning studies shall be representative of those proposed for use in the project and shall be accompanied by the manufacturer's or producer's test reports indicating compliance with these specifications. Trial mixtures having proportions, consistencies, and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratios required in the paragraph Maximum Allowable w/c Ratio will be the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus pozzolan, silica fume, and ground granulated blast furnace slag (GGBF slag) by the weight equivalency method as described in ACI 211.1. In the case where silica fume or GGBF slag is used, the weight of the silica fume and GGBF slag shall be included in the equations in ACI 211.1 for the term P, which is used to denote the weight of pozzolan. If pozzolan is used in the concrete mixture, the minimum pozzolan content shall be 15 percent by weight of the total cementitious material, and the maximum shall be 35 percent. Laboratory trial mixtures shall be designed for maximum permitted slump and air content. Separate sets of trial mixture studies shall be made for each combination of cementitious materials and each combination of admixtures proposed for use. No combination of either shall be used until proven by such studies, except that, if approved in writing and otherwise permitted by these specifications, an accelerator or a retarder may be used without separate trial mixture study. Separate trial mixture studies shall also be made for concrete for any conveying or placing method proposed which requires special properties and for concrete to be placed in unusually difficult placing locations. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance withASTM C 192/C 192M. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results, a curve shall be plotted showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, a curve shall be plotted showing the relationship between 7 day and 28 day strengths. Each mixture shall be designed to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding.

1.9.2 Proportioning Studies for Flexural Strength Concrete

****

NOTE: Retain this paragraph only when the design requires flexural strength concrete.

****

Trial design batches, mixture proportioning studies, and testing requirements shall conform to the requirements specified in paragraph Proportioning Studies for Normal Weight Concrete, except that proportions shall be based on flexural strength as determined by test specimens (beams) fabricated in accordance with ASTM C 192/C 192M and tested in accordance with ASTM C 78. Procedures given in ACI 211.1 shall be modified as necessary to accommodate flexural strength.

1.9.3 Proportioning Studies for Lightweight Aggregate Structural Concrete

Trial design batches, mixture proportioning studies, and testing requirements shall conform to the requirements specified in paragraph Proportioning Studies for Normal Weight Concrete, except as follows. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on methodology described in ACI 211.2, using at least three different cement contents. Trial mixes shall be proportioned to produce air dry unit weight and concrete strengths specified in paragraph GENERAL REQUIREMENTS. Trial mixtures shall be proportioned for maximum permitted slump and air content. Test specimens and testing shall be as specified for normal weight concrete except that [28-day compressive strength] [splitting tensile strength in accordance with ASTM C 496] shall be determined from test cylinders that have been air dried at 50 percent relative humidity for the last 21 days. Air dry unit weight shall be determined in accordance with ASTM C 567 and shall be designed to be at least 2.0 pcf less than the maximum specified air dry unit weight in paragraph GENERAL REQUIREMENTS. Curves shall be plotted using these results showing the relationship between cement factor and strength and air dry unit weight. Normal weight fine aggregate may be substituted for part or all of the lightweight fine aggregate, provided the concrete meets the strength and unit weight. A correlation shall also be developed showing the ratio between air dry unit weight and fresh concrete unit weight for each mix.

1.9.4 Average Compressive Strength Required for Mixtures

The mixture proportions selected during mixture design studies shall produce a required average compressive strength (f'cr) exceeding the specified compressive strength (f'c) by the amount indicated below. This required average compressive strength, f'cr, will not be a required acceptance criteria during concrete production. However, whenever the daily average compressive strength at 28 days drops below f'cr during concrete production, or daily average 7-day strength drops below a strength correlated with the 28-day f'cr, the mixture shall be adjusted, as approved, to bring the daily average back up to f'cr. During production, the required f'cr shall be adjusted, as appropriate, based on the standard deviation being attained on the job.

1.9.4.1 Computations from Test Records

Where a concrete production facility has test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 214.3R. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths (f'c) within 1,000 psi of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days. Required average compressive strength f'cr used as the basis for selection of concrete proportions shall be the larger of the equations that follow using the standard deviation as determined above:

f'cr = f'c + 1.34S where units are in psi

f'cr = f'c + 2.33S - 500 where units are in psi

Where S = standard deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and a modification factor from the following table:

NUMBER OF TESTS	MODIFICATION FACTOR FOR STANDARD DEVIATION
15	1.16
20	1.08
25	1.03
30 or more	1.00

1.9.4.2 Computations without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, the required average strength f'cr shall be determined as follows:

a. If the specified compressive strength f'c is less than 3,000 psi,

f'cr = f'c + 1000 psi

b. If the specified compressive strength f'c is 3,000 to 5,000 psi, f'cr = f'c + 1,200 psi

c. If the specified compressive strength f'c is over 5,000 psi,

f'cr = f'c + 1,400 psi

1.9.5 Average Flexural Strength Required for Mixtures

****

NOTE: Retain this paragraph when flexural strength mixtures are used.

****

The mixture proportions selected during mixture design studies for flexural strength mixtures and the mixture used during concrete production shall be designed and adjusted during concrete production as approved, except that the overdesign for average flexural strength shall simply be 15 percent greater than the specified flexural strength at all times.

1.9.6 Mix Design for Bonded Topping for Heavy Duty Floors

****

NOTE: Retain this paragraph when design requires heavy duty floors.

****

The concrete mix design for bonded topping for heavy duty floors shall contain the greatest practical proportion of coarse aggregate within the specified proportion limits. The mix shall be designed to produce concrete having a 28-day strength of at least 5000 psi. Concrete for the topping shall consist of the following proportions, by weight:

1.00 part portland cement
1.15 to 1.25 parts fine aggregate
1.80 to 2.00 parts coarse aggregate

Maximum w/c shall be 0.33. The topping concrete shall not be air-entrained. The concrete shall be mixed so as to produce a mixture of the driest consistency possible to work with a sawing motion of the strike-off and which can be floated and compacted as specified without producing water or excess cement at the surface. In no case shall slump exceed 1 inch as determined by ASTM C 143.

1.10 STORAGE OF MATERIALS

Cement and other cementitious materials shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants and keep each material completely separated. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Aggregate shall not be stored directly on ground unless a sacrificial layer is left undisturbed. Reinforcing bars and accessories shall be stored above the ground on platforms, skids or other supports. Other materials shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not be used unless retested and proven to meet the specified requirements. Materials shall be capable of being accurately identified after bundles or containers are opened.

1.11 GOVERNMENT ASSURANCE INSPECTION AND TESTING

Day-to day inspection and testing shall be the responsibility of the Contractor Quality Control (CQC) staff. However, representatives of the Contracting Officer can and will inspect construction as considered appropriate and will monitor operations of the Contractor's CQC staff. Government inspection or testing will not relieve the Contractor of any of his CQC responsibilities.

1.11.1 Materials

The Government will sample and test aggregates, cementitious materials, other materials, and concrete to determine compliance with the specifications as considered appropriate. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Other materials will be sampled from storage at the jobsite or from other locations as considered appropriate. Samples may be placed in storage for later testing when appropriate.

1.11.2 Fresh Concrete

Fresh concrete will be sampled as delivered in accordance with ASTM C 172 and tested in accordance with these specifications, as considered necessary.

1.11.3 Hardened Concrete

Tests on hardened concrete will be performed by the Government when such tests are considered necessary.

1.11.4 Inspection

Concrete operations may be tested and inspected by the Government as the project progresses. Failure to detect defective work or material will not prevent rejection later when a defect is discovered nor will it obligate the Government for final acceptance.

PART 2 PRODUCTS

****

NOTE: Edit this PART to include only those products which are locally available, are required by the project, and are acceptable to the designer.

****

2.1 CEMENTITIOUS MATERIALS

****

NOTE: EPA regulations mandate to "always permit the use" of fly ash (pozzolan) unless a valid overriding technical reason exists; but it is not necessary to require its use.

Include the limits on soluble alkalies for portland cement and for pozzolan whenever there is a

possibility of alkali-aggregate reactive aggregates being furnished.

Where alkali-bearing soil or groundwater is encountered, or where the concrete will be exposed to seawater, brackish water, or sewage, see ACI 201.2 R for guidance on selecting cementitious material. See EM 1110-2-2000 for guidance when proposing to use any type of portland-pozzolan or portland-furnace-slag cement.

Edit bracketed items as required.
****

Cementitious Materials shall be portland cement, [portland-pozzolan cement,] [portland blast-furnace slag cement,] or portland cement in combination with [pozzolan] [or ground granulated blast furnace slag] [or silica fume] and shall conform to appropriate specifications listed below. Use of cementitious materials in concrete which will have surfaces exposed in the completed structure shall be restricted so there is no change in color, source, or type of cementitious material.

2.1.1   Portland Cement

ASTM C 150, Type I [low alkali] with a maximum 15 percent amount of tricalcium aluminate, or Type II [low alkali] [including false set requirements] or [Type V]. White portland cement shall meet the above requirements except that it may be Type I, Type II or Type III [low alkali]. White Type III shall be used only in specific areas of the structure, when approved in writing.

2.1.2   High-Early-Strength Portland Cement

ASTM C 150, Type III with tricalcium aluminate limited to [5] [8] percent, [low alkali]. Type III cement shall be used only in isolated instances and only when approved in writing.

2.1.3   Blended Cements

****
NOTE: Never specify I(PM) or I(SM) cement.
****

ASTM C 595, Type [IP] [IP (MS)] [IP (MH)] [IS] [IS (MS)] [IS (MH)].

2.1.4   Pozzolan (Fly Ash)

ASTM C 618, Class [C] [F] with the optional requirements for multiple factor, drying shrinkage, and uniformity from Table 2A of ASTM C 618. [Requirement for maximum alkalies from Table 1A of ASTM C 618 shall apply]. If pozzolan is used, it shall never be less than 15 percent nor more than 35 percent by weight of the total cementitious material.

2.1.5   Ground Granulated Blast-Furnace (GGBF) Slag

ASTM C 989, Grade 120.

2.1.6   Silica Fume

****
NOTE: Silica Fume Concrete should be used where low permeability and enhanced durability are necessary and justified by additional cost, such as marine structures, other places where low permeability is needed, and severe abrasion resistance. Finishing is more difficult than conventional concrete. Proper curing is essential because there is a strong tendency for severe plastic shrinkage cracking.

Supervision by manufacturer's representative should be required during batching, finishing, and curing at start-up of the job. A HRWR recommended by the manufacturer of the silica fume should be used.
****

Silica fume shall conform to ASTM C 1240. Available alkalies shall conform to the optimal limit given in Table 2 of ASTM C 1240. Silica fume may be furnished as a dry, densified material or as a slurry. In accordance with paragraph Technical Service for Specialized Concrete, the Contractor shall provide at no cost to the Government the services of a manufacturer's technical representative experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume.

2.2 AGGREGATES

****
NOTE: Edit and fill in the blanks as appropriate. Consideration should always be given to the local aggregate supply situation, quality, and availability.
****

Aggregates shall conform to the following.

2.2.1 Fine Aggregate

Fine aggregate shall conform to the quality and gradation requirements of ASTM C 33.

2.2.2 Coarse Aggregate

Coarse aggregate shall conform to ASTM C 33, Class 5S, size designation [_____].

2.2.3 Lightweight Aggregate

Lightweight fine and coarse aggregate shall conform to the quality and gradation requirements of ASTM C 330, size [_____] for coarse aggregate. Lightweight aggregate shall be prewetted in accordance with the Manufacturer's instructions unless otherwise specified. For pumped concrete, prewetting shall be sufficient to ensure that slump loss through the pump line does not exceed 4 inches.

2.2.4 Materials for Bonded Topping for Heavy Duty Floors

In addition to the requirements specified above, coarse aggregate used for this purpose shall be a well graded, hard, sound diabase, trap rock, emery, granite or other natural or manufactured aggregate having equivalent hardness and wearing qualities and shall have a percentage of loss not to exceed 30 after 500 revolutions when tested in accordance with ASTM C 131. Gradation of the aggregates when tested in accordance with ASTM C 136 shall be as follows:

Coarse Aggregate

Sieve Size	Cumulative Percent By Weight Passing
3/4 in.	100
1/2 in.	50-100
3/8 in.	25-50
No. 4	0-15
No. 8	0-8

Fine Aggregate

Sieve Size	Cumulative Percent By Weight Passing
3/8 in.	100
No. 4	95-100
No. 8	65-80
No. 16	45-65
No. 30	25-45
No. 50	5-15
No. 100	0-5

2.3 CHEMICAL ADMIXTURES

****
NOTE: Edit as appropriate for the project. Do not permit the use of calcium chloride.
****

Chemical admixtures, when required or permitted, shall conform to the appropriate specification listed. Admixtures shall be furnished in liquid form and of suitable concentration for easy, accurate control of dispensing.

2.3.1 Air-Entraining Admixture

ASTM C 260 and shall consistently entrain the air content in the specified ranges under field conditions.

2.3.2 Accelerating Admixture

ASTM C 494, Type C or E, except that calcium chloride or admixtures containing calcium chloride shall not be used.

2.3.3 Water-Reducing or Retarding Admixture

ASTM C 494, Type A, B, or D, except that the 6-month and 1-year compressive and flexural strength tests are waived.

2.3.4   High-Range Water Reducer

****

NOTE: Use this paragraph only when high-range water reducing admixture is allowed in paragraph SLUMP in PART 1.

****

ASTM C 494, Type F or G, except that the 6-month and 1-year strength requirements are waived. The admixture shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of separate mixture design studies.

2.3.5   Surface Retarder

COE CRD-C 94.

2.3.6   Expanding Admixture

Aluminum powder type expanding admixture conforming to ASTM C 937.

2.3.7   Other Chemical Admixtures

****

NOTE: Use this paragraph only when a plasticizing admixture is allowed in paragraph SLUMP in PART 1.

****

Chemical admixtures for use in producing flowing concrete shall comply with ASTM C 1017, Type I or II. These admixtures shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of separate mixture design studies.

2.4   CURING MATERIALS

2.4.1   Impervious-Sheet

Impervious-sheet materials shall conform to ASTM C 171, type optional, except, that polyethylene sheet shall not be used.

2.4.2   Membrane-Forming Compound

Membrane-Forming curing compound shall conform to ASTM C 309, Type 1-D or 2, except that only a styrene acrylate or chlorinated rubber compound meeting Class B requirements shall be used for surfaces that are to be painted or are to receive bituminous roofing, or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing, or flooring specified. Nonpigmented compound shall contain a fugitive dye, and shall have the reflective requirements in ASTM C 309 waived.

2.4.3   Burlap and Cotton Mat

Burlap and cotton mat used for curing shall conform to AASHTO M 182.

2.5 WATER

Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water may be used if it meets the requirements of COE CRD-C 400.

2.6 NONSHRINK GROUT

Nonshrink grout shall conform to ASTM C 1107, Grade [A] [B] [C], and shall be a commercial formulation suitable for the proposed application.

2.7 NONSLIP SURFACING MATERIAL

Nonslip surfacing material shall consist of 55 percent, minimum, aluminum oxide or silicon-dioxide abrasive ceramically bonded together to form a homogeneous material sufficiently porous to provide a good bond with portland cement paste; or factory-graded emery aggregate consisting of not less than 45 percent aluminum oxide and 25 percent ferric oxide. The aggregate shall be well graded from particles retained on the No. 30 sieve to particles passing the No. 8 sieve.

2.8 LATEX BONDING AGENT

Latex agents for bonding fresh to hardened concrete shall conform to ASTM C 1059.

2.9 EPOXY RESIN

Epoxy resins for use in repairs shall conform to ASTM C 881, Type V, Grade 2. Class as appropriate to the existing ambient and surface temperatures.

2.10 EMBEDDED ITEMS

Embedded items shall be of the size and type indicated or as needed for the application. Dovetail slots shall be galvanized steel. Hangers for suspended ceilings shall be as specified in Section 09510 ACOUSTICAL CEILINGS. Inserts for shelf angles and bolt hangers shall be of malleable iron or cast or wrought steel.

2.11 FLOOR HARDENER

****

NOTE: Floor hardener should only be specified on specialized indoor floors where dusting of concrete would present an unusual problem or where specially requested by the Using Service.

****

Floor hardener shall be a colorless aqueous solution containing zinc silicofluoride, magnesium silicofluoride, or sodium silicofluoride. These silicofluorides can be used individually or in combination. Proprietary hardeners may be used if approved in writing by the Contracting Officer.

2.12 PERIMETER INSULATION

****

NOTE: Show required K-value on the drawings.

****

Perimeter insulation shall be polystyrene conforming to ASTM C 578, Type II; polyurethane conforming to ASTM C 591, Type II; or cellular glass conforming to ASTM C 552, Type I or IV.

2.13 VAPOR BARRIER

Vapor barrier shall be polyethylene sheeting with a minimum thickness of 6 mils or other equivalent material having a vapor permeance rating not exceeding 0.5 perms as determined in accordance with ASTM E 96.

2.14 JOINT MATERIALS

2.14.1 Joint Fillers, Sealers, and Waterstops

****

NOTE: Do not use bituminous filler with non-bituminous sealer. Designer will edit bracketed items for joint sealing.

****

Expansion joint fillers shall be preformed materials conforming to [ASTM D 1751] [ASTM D 1752]. Materials for waterstops shall be in accordance with Section 03150 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS. Materials for and sealing of joints shall conform to the requirements of Section [07900 JOINT SEALING] [02760 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS] [02762 COMPRESSION JOINT SEALS FOR CONCRETE PAVEMENTS].

2.14.2 Contraction Joints in Slabs

Sawable type contraction joint inserts shall conform to COE CRD-C 540. Nonsawable joint inserts shall have sufficient stiffness to permit placement in plastic concrete without undue deviation from a straight line and shall conform to the physical requirements of COE CRD-C 540, with the exception of Section 3.4 "Resistance to Sawing". Plastic inserts shall be polyvinyl chloride conforming to the materials requirements of COE CRD-C 572.

2.15 SYNTHETIC FIBERS FOR REINFORCING

****

NOTE: Use fiber reinforcement only when approved by the designer; in that case retain this paragraph. Drawings should indicate where fiber reinforced concrete is located. Fiber reinforcing is used to help control cracking due to drying shrinkage and thermal expansion/contraction; reduce permeability; and increase impact capacity, shatter and abrasion resistance, and toughness. Fiber reinforcing will not: control cracking due to structural stresses, significantly increase strength, control curling or creeping, justify reducing structural members, eliminate control joints, or replace any moment or structural steel reinforcement. Include flexural toughness tests when synthetic reinforcement fibers are used to increase toughness and when justified by size and importance of the job, but not when fibers

are used only to control shrinkage cracking. Include technical representative requirement when warranted by size and importance of the job.
****

Synthetic fibers shall conform to ASTM C 1116, Type III, Synthetic Fiber, and as follows. Fibers shall be 100 percent virgin polypropylene fibrillated fibers containing no reprocessed olefin materials. Fibers shall have a specific gravity of 0.9, a minimum tensile strength of 70 ksi graded per manufacturer, and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement.

2.16 DRY SHAKE FLOOR TOPPING MATERIAL

****
NOTE: Edit and supplement this paragraph for light reflective, spark resistant, static disseminating floors as applicable to the project.
****

Dry shake floor topping material shall be a premixed ready-to-use dry shake. It shall be proportioned, mixed and packaged at the factory, and delivered to the jobsite in sealed, moisture resistant bags, ready to apply, finish and cure. The manufacturer of the dry shake material shall have at least 10 years experience in the manufacture of such material. Any material from a manufacturer who makes any disclaimer of the materials performance shall not be used.

PART 3 EXECUTION

3.1 PREPARATION FOR PLACING

Before commencing concrete placement, the following shall be performed. Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Forms shall be in place, cleaned, coated, and adequately supported, in accordance with Section 03100 STRUCTURAL CONCRETE FORMWORK. Reinforcing steel shall be in place, cleaned, tied, and adequately supported, in accordance with Section 03200 CONCRETE REINFORCEMENT. Transporting and conveying equipment shall be in-place, ready for use, clean, and free of hardened concrete and foreign material. Equipment for consolidating concrete shall be at the placing site and in proper working order. Equipment and material for curing and for protecting concrete from weather or mechanical damage shall be at the placing site, in proper working condition and in sufficient amount for the entire placement. When hot, windy conditions during concreting appear probable, equipment and material shall be at the placing site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete.

3.1.1 Foundations

3.1.1.1 Concrete on Earth Foundations

Earth (subgrade, base, or subbase courses) surfaces upon which concrete is to be placed shall be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, the foundation shall be well drained and shall be satisfactorily graded and uniformly compacted.

3.1.1.2 Preparation of Rock

Rock surfaces upon which concrete is to be placed shall be free from oil, standing or running water, ice, mud, drummy rock, coating, debris, and loose, semidetached or unsound fragments. Joints in rock shall be cleaned to a satisfactory depth, as determined by the Contracting Officer, and to firm rock on the sides. Immediately before the concrete is placed, rock surfaces shall be cleaned thoroughly by the use of air-water jets or sandblasting as specified below for Previously Placed Concrete. Rock surfaces shall be kept continuously moist for at least 24 hours immediately prior to placing concrete thereon. All horizontal and approximately horizontal surfaces shall be covered, immediately before the concrete is placed, with a layer of mortar proportioned similar to that in the concrete mixture. Concrete shall be placed before the mortar stiffens.

3.1.1.3 Excavated Surfaces in Lieu of Forms

****
NOTE: Delete this paragraph when forms are required.
****

Concrete for [footings] [and] [walls] may be placed directly against the soil provided the earth or rock has been carefully trimmed, is uniform and stable, and meets the compaction requirements of Section 02315EXCAVATION, FILLING, AND BACKFILLING FOR BUILDINGS. The concrete shall be placed without becoming contaminated by loose material, and the outline of the concrete shall be within the specified tolerances.

3.1.2 Previously Placed Concrete

****
NOTE: If structure has few construction joints to be bonded, none of them critical, remove the following requirements except for subparagraph Preparation of Previously Placed Concrete. Otherwise, use the following requirements and remove subparagraph Preparation of Previously Placed Concrete.
****

Concrete surfaces to which additional concrete is to be bonded shall be prepared for receiving the next horizontal lift by cleaning the construction joint surface with either air-water cutting, sandblasting, high-pressure water jet, or other approved method. Concrete at the side of vertical construction joints shall be prepared as approved by the Contracting Officer. Air-water cutting shall not be used on formed surfaces or surfaces congested with reinforcing steel. Regardless of the method used, the resulting surfaces shall be free from all laitance and inferior concrete so that clean surfaces of well bonded coarse aggregate are exposed and make up at least 10-percent of the surface area, distributed uniformly throughout the surface. The edges of the coarse aggregate shall not be undercut. The surface of horizontal construction joints shall be kept continuously wet for the first 12 hours during the 24-hour period prior to placing fresh concrete. The surface shall be washed completely clean as the last operation prior to placing the next lift. For heavy duty floors and two-course floors a thin coat of neat cement grout of about the consistency of thick cream shall be thoroughly scrubbed into the existing surface immediately ahead of the topping placing. The grout shall be a 1:1 mixture of portland cement and sand passing the No. 8 sieve. The topping concrete shall be deposited before the grout coat has had time to stiffen.

3.1.2.1 Air-Water Cutting

Air-water cutting of a fresh concrete surface shall be performed at the proper time and only on horizontal construction joints. The air pressure used in the jet shall be 100 psi plus or minus, 10 psi, and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. When approved by the Contracting Officer, a surface retarder complying with the requirements of COE CRD-C 94 may be applied to the surface of the lift in order to prolong the period of time during which air-water cutting is effective. After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, high-pressure waterjet or sandblasting shall be used as the last operation before placing the next lift.

3.1.2.2 High-Pressure Water Jet

A stream of water under a pressure of not less than 3,000 psi shall be used for cutting and cleaning. Its use shall be delayed until the concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse-aggregate particles. If the waterjet is incapable of a satisfactory cleaning, the surface shall be cleaned by sandblasting.

3.1.2.3 Wet Sandblasting

Wet sandblasting shall be used after the concrete has reached sufficient strength to prevent undercutting of the coarse aggregate particles. After wet sandblasting, the surface of the concrete shall then be washed thoroughly to remove all loose materials.

3.1.2.4 Waste Disposal

The method used in disposing of waste water employed in cutting, washing, and rinsing of concrete surfaces shall be such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal shall be subject to approval.

3.1.2.5 Preparation of Previously Placed Concrete

****

NOTE: When the structure has few construction joints to be bonded, none of them critical, use this subparagraph and delete requirements of above subparagraphs and of paragraph Previously Placed Concrete. Renumber this specification accordingly.

****

Concrete surfaces to which other concrete is to be bonded shall be abraded in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Laitance and loose particles shall be removed. Surfaces shall be thoroughly washed and shall be moist but without free water when concrete is placed.

3.1.3   Vapor Barrier

****
NOTE: When this paragraph is used, coordinate drawings and specifications ensuring that drawings indicate vapor barrier beneath slabs. Retain the penultimate sentence unless experience in the area has shown it to be unnecessary.
****

Vapor barrier shall be provided beneath the interior on-grade concrete floor slabs. The greatest widths and lengths practicable shall be used to eliminate joints wherever possible. Joints shall be lapped a minimum of 12 inches. Torn, punctured, or damaged vapor barrier material shall be removed and new vapor barrier shall be provided prior to placing concrete. For minor repairs, patches may be made using laps of at least 12 inches. Lapped joints shall be sealed and edges patched with pressure-sensitive adhesive or tape not less than 2 inches wide and compatible with the membrane. Vapor barrier shall be placed directly on underlying subgrade, base course, or capillary water barrier, unless it consists of crushed material or large granular material which could puncture the vapor barrier. In this case, the surface shall be choked with a light layer of sand, as approved, before placing the vapor barrier. A 2 inch layer of compacted, clean concrete sand (fine aggregate) shall be placed on top of the vapor barrier before placing concrete. Concrete placement shall be controlled so as to prevent damage to the vapor barrier, or any covering sand.

3.1.4   Perimeter Insulation

****
NOTE: When this paragraph is used, ensure that drawings indicate location and extent of perimeter insulation.
****

Perimeter insulation shall be installed at locations indicated. Adhesive shall be used where insulation is applied to the interior surface of foundation walls and may be used for exterior application.

3.1.5   Embedded Items

Before placement of concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Conduit and other embedded items shall be clean and free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids. Welding shall not be performed on embedded metals within 1 feet of the surface of the concrete. Tack welding shall not be performed on or to embedded items.

3.2   CONCRETE PRODUCTION

****
NOTE: Use this paragraph and its subparagraphs for

all projects except where designer chooses to use the following optional paragraph CONCRETE PRODUCTION, SMALL PROJECTS, provided it meets the criteria described therein, in which case delete these. Do not specify both options.

****

3.2.1 Batching, Mixing, and Transporting Concrete

****

NOTE: The designer must choose one of the two bracketed requirements and delete the other. Do not use the first bracketed requirement if ready-mixed concrete is not wanted.

****

[Concrete shall either be batched and mixed onsite or shall be furnished from a ready-mixed concrete plant. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and nonagitating transporting units shall comply with NRMCA TMMB 100. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Approved batch tickets shall be furnished for each load of ready-mixed concrete. Site-mixed concrete shall conform to the following subparagraphs.] [Concrete shall be batched and mixed onsite, or close to onsite, and shall conform to the following subparagraphs.]

3.2.1.1 General

****

NOTE: Choose the desired bracketed options for plant locations. Insert desired minimum capacity of plant, it should be sufficient to accommodate the largest placement within a reasonable time.

****

The batching plant shall be located [on site in the general area indicated on the drawings] [or] [off site close to the project]. The batching, mixing and placing system shall have a capacity of at least [_____] cubic yards per hour. The batching plant shall conform to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required.

3.2.1.2 Batching Equipment

****

NOTE: Retain the bracketed sentence concerning truck mixers unless it is desired to prohibit truck mixers. Always retain bracketed item about silica fume when its use is allowed, otherwise delete.

****

The batching controls shall be semiautomatic or automatic, as defined in NRMCA CPMB 100. A semiautomatic batching system shall be provided with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance. The batching system shall be equipped with accurate recorder or recorders that meet the requirements of NRMCA CPMB 100. The weight of water and admixtures shall be recorded if batched by weight. Separate bins or compartments shall be provided for each size group of aggregate and type of cementitious material, to prevent intermingling at any time. Aggregates shall be weighed either in separate weigh batchers with individual scales or, provided the smallest size is batched first, cumulatively in one weigh batcher on one scale. Aggregate shall not be weighed in the same batcher with cementitious material. If both portland cement and other cementitious material are used, they may be batched cumulatively, provided that the portland cement is batched first, [except that silica fume shall always be batched separately]. Water may be measured by weight or volume. Water shall not be weighed or measured cumulatively with another ingredient. Filling and discharging valves for the water metering or batching system shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. Piping for water and for admixtures shall be free from leaks and shall be properly valved to prevent backflow or siphoning. Admixtures shall be furnished as a liquid of suitable concentration for easy control of dispensing. An adjustable, accurate, mechanical device for measuring and dispensing each admixture shall be provided. Each admixture dispenser shall be interlocked with the batching and discharging operation of the water so that each admixture is separately batched and individually discharged automatically in a manner to obtain uniform distribution throughout the water as it is added to the batch in the specified mixing period. [When use of truck mixers makes this requirement impractical, the admixture dispensers shall be interlocked with the sand batchers]. Different admixtures shall not be combined prior to introduction in water and shall not be allowed to intermingle until in contact with the cement. Admixture dispensers shall have suitable devices to detect and indicate flow during dispensing or have a means for visual observation. The plant shall be arranged so as to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each bin or compartment, and for sampling and calibrating the dispensing of cementitious material, water, and admixtures. Filling ports for cementitious materials bins or silos shall be clearly marked with a permanent sign stating the contents.

3.2.1.3 Scales

The weighing equipment shall conform to the applicable requirements of CPMB Concrete Plant Standard, and of NIST HB 44, except that the accuracy shall be plus or minus 0.2 percent of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. The tests shall be made at the specified frequency in the presence of a Government inspector. The weighing equipment shall be arranged so that the plant operator can conveniently observe all dials or indicators.

3.2.1.4 Batching Tolerances

(A) Tolerances with Weighing Equipment

MATERIAL	PERCENT OF REQUIRED WEIGHT
Cementitious materials	0 to plus 2

MATERIAL	PERCENT OF REQUIRED WEIGHT
Aggregate	plus or minus 2
Water	plus or minus 1
Chemical admixture	0 to plus 6

(B) Tolerances with Volumetric Equipment

For volumetric batching equipment used for water and admixtures, the following tolerances shall apply to the required volume of material being batched:

MATERIAL	PERCENT OF REQUIRED MATERIAL
Water:	plus or minus 1 percent
Chemical admixtures:	0 to plus 6 percent

3.2.1.5 Moisture Control

The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the weights of the materials being batched.

3.2.1.6 Concrete Mixers

****
NOTE: Retain bracketed phrase unless it is desired to prohibit truck mixers, in which case delete.
****

Mixers shall be stationary mixers [or truck mixers]. Mixers shall be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. The mixers shall not be charged in excess of the capacity recommended by the manufacturer. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The mixers shall be maintained in satisfactory operating condition, and the mixer drums shall be kept free of hardened concrete. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

3.2.1.7 Stationary Mixers

Concrete plant mixers shall be drum-type mixers of tilting, nontilting, horizontal-shaft, or vertical-shaft type, or shall be pug mill type and shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity shall conform to all the requirements in ASTM C 94 applicable to central-mixed concrete.

3.2.1.8 Truck Mixers

****
NOTE: Delete this subparagraph if truck mixers have been previously prohibited, otherwise retain. Use bracketed item only for small jobs.
****

Truck mixers, the mixing of concrete therein, and concrete uniformity shall conform to the requirements of ASTM C 94. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall be equipped with two counters from which it is possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed. [Or, if approved in lieu of this, the number of revolutions shall be marked on the batch tickets.] Water shall not be added at the placing site unless specifically approved; and in no case shall it exceed the specified w/c. Any such water shall be injected at the base of the mixer, not at the discharge end.

3.3 CONCRETE PRODUCTION, SMALL PROJECTS

****

NOTE: Use this paragraph at the designer's option in lieu of the previous paragraph CONCRETE PRODUCTION and its subparagraphs, which must then be deleted, but only when all the following conditions exist:

(a) There are no particularly critical structural items.

(b) There are no items of particularly critical appearance.

(c) No concrete is required with a specified compressive strength greater than 24.2 MPa (3500 psi).

(d) Not over 1150 cubic meteres (1500 cubic yards) of concrete are required.

Otherwise, use the above listed previous paragraph and subparagraphs only. Do not specify both options.

****

Batch-type equipment shall be used for producing concrete. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and nonagitating transporting units shall comply with NRMCA TMMB 100. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Approved batch tickets shall be furnished for each load of ready-mixed concrete. Site-mixed concrete shall be produced in accordance with ACI 301, and plant shall conform to NRMCA CPMB 100. [In lieu of batch-type equipment, concrete may be produced by volumetric batching and continuous mixing, which shall conform to ASTM C 685.]

3.4 LIGHTWEIGHT AGGREGATE CONCRETE

In addition to the requirements specified for normal weight concrete, lightweight aggregate concrete shall conform to the following. The batching and mixing cycle shall be as directed based on written recommendations from the aggregate supplier which the Contractor shall furnish. Unless otherwise directed, the mixer shall be charged with approximately 2/3 of the total mixing water and all of the aggregate. This shall be mixed for at least 1-1/2 minutes in a stationary mixer or 15 revolutions at mixing speed in a truck mixer. The remaining ingredients shall then be added and mixing continued as specified for normal weight concrete. Lightweight aggregate concrete shall not be vibrated to the extent that large particles of aggregate float to the surface. During finishing, lightweight aggregate concrete shall not be worked to the extent that mortar is driven down and lightweight coarse aggregate appears at the surface. Lightweight aggregate concrete to be pumped shall have a cement content of at least 564 lb. per cu. yd. [A field trial run of lightweight aggregate concrete placement and finishing shall be made in accordance with ACI 213R.]

3.5 FIBER REINFORCED CONCRETE

****

NOTE: Only use fiber reinforcing when approved by the structural designer. Drawings should indicate where fiber reinforced concrete is located. Fiber reinforcing is used (1) to help control cracking due to drying shrinkage and thermal expansion and contraction, (2) to reduce permeability, (3) to increase impact capability, shatter resistance, abrasion resistance, and toughness. Fiber reinforcing will not: control cracking due to structural stresses, significantly increase strength, control curling or creeping, justify reducing structural members, eliminate control joints, or replace any moment or structural steel reinforcement. Include flexural toughness tests when synthetic reinforcement fibers are used to increase toughness and when justified by size and importance of job, but not when fibers are used only to control shrinkage cracking. Include technical representative when warranted by size and importance of job.

****

Fiber reinforced concrete shall conform to ASTM C 1116 and as follows, using the fibers specified in PART 2. A minimum of 1.5 pounds of fibers per cubic yard of concrete shall be used. Fibers shall be added at the batch plant. [Toughness indices shall meet requirements for performance level I of ASTM C 1116.] The services of a qualified technical representative shall be provided to instruct the concrete supplier in proper batching and mixing of materials to be provided.

3.6 TRANSPORTING CONCRETE TO PROJECT SITE

Concrete shall be transported to the placing site in [truck mixers,] [agitators,] [nonagitating transporting equipment conforming to NRMCA TMMB 100] or by approved [pumping equipment] [conveyors]. Nonagitating equipment, other than pumps, shall not be used for transporting lightweight aggregate concrete.

3.7 CONVEYING CONCRETE ON SITE

****

NOTE: Delete conveying equipment not wanted on the project.
****

Concrete shall be conveyed from mixer or transporting unit to forms as rapidly as possible and within the time interval specified by methods which will prevent segregation or loss of ingredients using following equipment. Conveying equipment shall be cleaned before each placement.

3.7.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least 5 times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 2 square feet.The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 2 cubic yardsshall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

3.7.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles and shall have conical-shaped discharge features. The transfer hopper shall be equipped with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Concrete shall not be held in nonagitating transfer hoppers more than 30 minutes.

3.7.3 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C 94. Nonagitating equipment shall be used only for transporting plant-mixed concrete over a smooth road and when the hauling time is less than 15 minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

3.7.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes normally attached to this equipment by the manufacturer may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

3.7.5 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means, such as discharge baffle or hopper , for preventing segregation of the concrete at the transfer points and the point of placing. Belt conveyors shall be constructed such that the idler spacing shall not exceed 36 inches. The belt speed shall be a minimum of 300 feet per minute and a maximum of 750 feet per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the conveyor shall discharge concrete into a pipe or elephant truck that is long enough to extend through the reinforcing bars.

3.7.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure type; pneumatic placing equipment shall not be used. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least 3 times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 4 inches. Aluminum pipe shall not be used.

3.8 PLACING CONCRETE

Mixed concrete shall be discharged within 1-1/2 hours or before the mixer drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates. When the concrete temperature exceeds 85 degrees F, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the transporting unit. Concrete shall be handled from mixer or transporting unit to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing. Sufficient placing capacity shall be provided so that concrete can be kept free of cold joints.

3.8.1 Depositing Concrete

Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 12 inches thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level. Concrete shall be deposited continuously in one layer or in layers so that fresh concrete is deposited on in-place concrete that is still plastic. Fresh concrete shall not be deposited on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. Concrete that has surface dried, partially hardened, or contains foreign material shall not be used. When temporary spreaders are used in the forms, the spreaders shall be removed as their service becomes unnecessary. Concrete shall not be placed in slabs over columns and walls until concrete in columns and walls has been in-place at least two hours or until the concrete begins to lose its plasticity. Concrete for beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as concrete for adjoining slabs.

3.8.2 Consolidation

****

NOTE: For large jobs, this paragraph may be

expanded. Consolidation equipment and procedures are described in detail in ACI 309.
****

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 4 inches thick or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 10,000 vibrations per minute, an amplitude of at least 0.025 inch, and the head diameter shall be appropriate for the structural member and the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a reasonable amount. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then vertically withdrawn slowly while operating. Form vibrators shall not be used unless specifically approved and unless forms are constructed to withstand their use. Vibrators shall not be used to move concrete within the forms. Slabs 4 inches and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique. Excessive vibration of lightweight concrete resulting in segration or flotation of coarse aggregate shall be prevented. Frequency and amplitude of vibrators shall be determined in accordance with COE CRD-C 521. Grate tampers ("jitterbugs") shall not be used.

3.8.3   Cold Weather Requirements

****
NOTE: When the designer is especially concerned about corrosion of reinforcing steel or embedded items, or possibility of sulfate attack, (particularly to prestressing steel) the percentage of chloride ion in the mixture should be limited. See ACI Committee 201 report "Guide to Durable Concrete" and ACI Committee 222 report "Corrosion of Metals in Concrete" for guidance on control of chloride ion.
****

Special protection measures, approved by the Contracting Officer, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. The ambient temperature of the air where concrete is to be placed and the temperature of surfaces to receive concrete shall be not less than 40 degrees F. The temperature of the concrete when placed shall be not less than 50 degrees F nor more than 75 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Upon written approval, an accelerating admixture conforming to ASTM C 494, Type C or E may be used, provided it contains no calcium chloride. Calcium chloride shall not be used.

3.8.4   Hot Weather Requirements

****

NOTE: If desired, placement of floor slabs may be specified to be delayed until a roof is in place. Additional information concerning hot weather concreting may be obtained from ACI 305R.

****

When the ambient temperature during concrete placing is expected to exceed 85 degrees F, the concrete shall be placed and finished with procedures previously submitted and as specified herein. The concrete temperature at time of delivery to the forms shall not exceed the temperature shown in the table below when measured in accordance with ASTM C 1064. Cooling of the mixing water or aggregates or placing concrete in the cooler part of the day may be required to obtain an adequate placing temperature. A retarder may be used, as approved, to facilitate placing and finishing. Steel forms and reinforcements shall be cooled as approved prior to concrete placement when steel temperatures are greater than 120 degrees F. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature.

Maximum Allowable Concrete Placing Temperature

Relative Humidity, Percent, During Time of Concrete Placement	Maximum Allowable Concrete Temperature Degrees
Greater than 60	90 F
40-60	85 F
Less than 40	80 F

3.8.5 Prevention of Plastic Shrinkage Cracking

During hot weather with low humidity, and particularly with appreciable wind, as well as interior placements when space heaters produce low humidity, the Contractor shall be alert to the tendency for plastic shrinkage cracks to develop and shall institute measures to prevent this. Particular care shall be taken if plastic shrinkage cracking is potentially imminent and especially if it has developed during a previous placement. Periods of high potential for plastic shrinkage cracking can be anticipated by use of Fig. 2.1.5 of ACI 305R. In addition the concrete placement shall be further protected by erecting shades and windbreaks and by applying fog sprays of water, sprinkling, ponding or wet covering. Plastic shrinkage cracks that occur shall be filled by injection of epoxy resin as directed, after the concrete hardens. Plastic shrinkage cracks shall never be troweled over or filled with slurry.

3.8.6 Placing Concrete Underwater

****

NOTE: Delete this paragraph when not applicable. If major underwater concrete placement is required, supplement this paragraph using guidance from ACI 304R. If appropriate, add special requirements for underwater concrete to paragraphs Concrete Proportioning Studies, Normal Weight Concrete and

General Requirements both in PART 1. If considered necessary, require a special technical representative in paragraph Technical Service for Specialized Concrete in PART 1. Contractor will be required to submit proposed procedures.
****

Concrete shall be deposited in water by a tremie or concrete pump. The methods and equipment used shall be subject to approval. Concrete buckets shall not be used for underwater placement of concrete except to deliver concrete to the tremie. The tremie shall be watertight and sufficiently large to permit a free flow of concrete. The concrete shall be deposited so that it enters the mass of the previously placed concrete from within, displacing water with a minimum disturbance to the surface of the concrete. The discharge end of the pump line or tremie shaft shall be kept continuously submerged in the concrete. The underwater seal at start of placing shall not produce undue turbulence in the water. The tremie shaft shall be kept full of concrete to a point well above the water surface. Placement shall proceed without interruption until the concrete has been brought to the required height. The tremie shall not be moved horizontally during a placing operation, and a sufficient number of tremies shall be provided so that the maximum horizontal flow of concrete will be limited to 15 feet. Concrete shall not be deposited in running water or in water with a temperature below 35 degrees F.

3.8.7 Placing Concrete in Congested Areas

****
NOTE: Delete the last sentence when not applicable.
****

Special care shall be used to ensure complete filling of the forms, elimination of all voids, and complete consolidation of the concrete when placing concrete in areas congested with reinforcing bars, embedded items, waterstops and other tight spacing. An appropriate concrete mixture shall be used, and the nominal maximum size of aggregate (NMSA) shall meet the specified criteria when evaluated for the congested area. Vibrators with heads of a size appropriate for the clearances available shall be used, and the consolidation operation shall be closely supervised to ensure complete and thorough consolidation at all points. Where necessary, splices of reinforcing bars shall be alternated to reduce congestion. Where two mats of closely spaced reinforcing are required, the bars in each mat shall be placed in matching alignment to reduce congestion. Reinforcing bars may be temporarily crowded to one side during concrete placement provided they are returned to exact required location before concrete placement and consolidation are completed.

3.8.8 Placing Flowable Concrete

****
NOTE: Delete this paragraph when flowable concrete is not permitted.
****

If a plasticizing admixture conforming to ASTM C 1017 is used or if a Type F or G high range water reducing admixture is permitted to increase the slump, the concrete shall meet all requirements of paragraph GENERAL REQUIREMENTS in PART 1. Extreme care shall be used in conveying and placing the concrete to avoid segregation. Consolidation and finishing shall meet all requirements of paragraphs Placing Concrete, Finishing Formed Surfaces, and Finishing Unformed Surfaces. No relaxation of requirements to accommodate flowable concrete will be permitted.

3.9 JOINTS

****

NOTE: All joints should be indicated on the drawings. When some of the joints are not shown, the Designer must edit this paragraph for conformance with job requirements.

****

Joints shall be located and constructed as indicated or approved. Joints not indicated on the drawings shall be located and constructed to minimize the impact on the strength of the structure. In general, such joints shall be located near the middle of the spans of supported slabs, beams, and girders unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and at the tops of footings or floor slabs, unless otherwise approved. Joints shall be perpendicular to the main reinforcement. All reinforcement shall be continued across joints; except that reinforcement or other fixed metal items shall not be continuous through expansion joints, or through construction or contraction joints in slabs on grade. Reinforcement shall be 2 inches clear from each joint. Except where otherwise indicated, construction joints between interior slabs on grade and vertical surfaces shall consist of 30 pound asphalt-saturated felt, extending for the full depth of the slab. The perimeters of the slabs shall be free of fins, rough edges, spalling, or other unsightly appearance. Reservoir for sealant for construction and contraction joints in slabs shall be formed to the dimensions shown on the drawings by removing snap-out joint-forming inserts, by sawing sawable inserts, or by sawing to widen the top portion of sawed joints. Joints to be sealed shall be cleaned and sealed as indicated and in accordance with Section 07900 JOINT SEALING.

3.9.1 Construction Joints

****

NOTE: Drawings must show details for construction joints, including any required dowels or keyways. Drawings must indicate whether dowels are conventional smooth "paving" dowels or "structural" type deformed dowels (tie-bars).

****

For concrete other than slabs on grade, construction joints shall be located so that the unit of operation does not exceed [_____] feet. Concrete shall be placed continuously so that each unit is monolithic in construction. Fresh concrete shall not be placed against adjacent hardened concrete until it is at least 24 hours old. Construction joints shall be located as indicated or approved. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of the Contracting Officer. Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Construction joints in slabs on grade shall be keyed or doweled as shown. Concrete columns, walls, or piers shall be in place at least 2 hours, or until the concrete begins to lose its plasticity, before placing concrete for beams, girders, or slabs thereon. In walls having door or window openings, lifts shall terminate at the top and bottom of the opening. Other lifts shall terminate at such levels as to conform to structural requirements or architectural details. Where horizontal construction joints in walls or columns are required, a strip of 1 inchsquare-edge lumber, bevelled and oiled to facilitate removal, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 1 inch above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, and any irregularities in the joint line shall be leveled off with a wood float, and all laitance shall be removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph Previously Placed Concrete.

3.9.2 Contraction Joints in Slabs on Grade

****
NOTE: Drawings must indicate desired location and detail for contraction joints.
****

Contraction joints shall be located and detailed as shown on the drawings. Contraction Joints shall be produced by forming a weakened plane in the concrete slab by [use of rigid inserts impressed in the concrete during placing operations] [use of snap-out plastic joint forming inserts] [or] [sawing a continuous slot with a concrete saw]. Regardless of method used to produce the weakened plane, it shall be 1/4 the depth of the slab thickness and between 1/8 and 3/16 inch wide. For saw-cut joints, cutting shall be timed properly with the set of the concrete. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent ravelling of the edges of the saw cut. Cutting shall be completed before shrinkage stresses become sufficient to produce cracking. Reservoir for joint sealant shall be formed as previously specified.

3.9.3 Expansion Joints

Installation of expansion joints and sealing of these joints shall conform to the requirements of Section 03150 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS and Section 07900 JOINT SEALING.

3.9.4 Waterstops

Waterstops shall be installed in conformance with the locations and details shown on the drawings using materials and procedures specified in Section 03150 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS.

3.9.5 Dowels and Tie Bars

Dowels and tie bars shall be installed at the locations shown on the drawings and to the details shown, using materials and procedures specified in Section 03200 CONCRETE REINFORCEMENT and herein. Conventional smooth "paving" dowels shall be installed in slabs using approved methods to hold the dowel in place during concreting within a maximum alignment tolerance of 1/8 inch in 12 inches. "Structural" type deformed bar dowels, or tie bars, shall be installed to meet the specified tolerances. Care shall be taken during placing adjacent to and around dowels and tie bars to ensure there is no displacement of the dowel or tie bar and that the concrete completely embeds the dowel or tie bar and is thoroughly consolidated.

3.10 FINISHING FORMED SURFACES

****

NOTE: Formwork, form materials and form construction are specified in Section 03100 STRUCTURAL CONCRETE FORMWORK. Classes of finish to be used for various formed surfaces of the structure must be indicated on the drawings or clearly specified herein. Criteria to use in choosing class of finish are as follows:

Class A Finish. This finish is for surfaces permanently exposed to public view that require excellent appearance at close range. Examples: Exterior walls of office and residential buildings, of warehouse/industrial type buildings where frequent public access occurs, and of other similar exposed structures; and interior walls, columns or beams of these same structures where no other finish treatment is to be added.

Class B Finish. This finish is for surfaces exposed to public view that do not require the excellent appearance of Class A. Exterior walls of warehouse/ industrial buildings where public access is infrequent, structures on combat training ranges, and other similar exposed structures; interior exposed surfaces of such structures, and interior surfaces of liquid containers.

Class C Finish. This finish is for concealed surfaces not exposed to view and for all surfaces not covered by Class A, B, or D finish. Examples: Interior surfaces that will be covered by dry wall or other applied surfaces, surfaces of mechanical rooms and elevator shafts.

Class D Finish. This finish is for surfaces where roughness and irregularities are not objectionable. Examples: Walls and foundation surfaces against which backfill will be placed, exterior surfaces permanently submerged in water where no coating is to be applied.

When a Class A or B Finish is specified, add to paragraph FIELD TEST PANELS in PART 1 requirements for the Contractor to construct a sample panel for approval before start of construction. Finishes for surfaces to be exposed to high velocity flow of water (above 40 ft per sec) will be designed and constructed in accordance with Civil Works criteria.

****

Forms, form materials, and form construction are specified in Section 03100 STRUCTURAL CONCRETE FORMWORK. Finishing of formed surfaces shall be as specified herein. Unless another type of architectural or special finish is specified, surfaces shall be left with the texture imparted by the forms except that defective surfaces shall be repaired. Unless painting of surfaces is required, uniform color of the concrete shall be maintained by use of only one mixture without changes in materials or proportions for any structure or portion of structure that requires a Class A or B finish. Except for major defects, as defined hereinafter, surface defects shall be repaired as specified herein within 24 hours after forms are removed. Repairs of the so-called "plaster-type" will not be permitted in any location. Tolerances of formed surfaces shall conform to the requirements of ACI 117/117R. These tolerances apply to the finished concrete surface, not to the forms themselves; forms shall be set true to line and grade. Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter shall be repaired as specified in paragraph Damp-Pack Mortar Repair. Defects whose surface diameter is greater than their depth shall be repaired as specified in paragraph Repair of Major Defects. Repairs shall be finished flush with adjacent surfaces and with the same surface texture. The cement used for all repairs shall be a blend of job cement with white cement proportioned so that the final color after curing and aging will be the same as the adjacent concrete. Concrete with excessive honeycomb, or other defects which affect the strength of the member, will be rejected. Repairs shall be demonstrated to be acceptable and free from cracks or loose or drummy areas at the completion of the contract and, for Class A and B Finishes, shall be inconspicuous. Repairs not meeting these requirements will be rejected and shall be replaced.

3.10.1 Class A Finish and Class B Finish

Class A finish is required [where indicated on the drawings.] [in the following areas, [_____].] Class B finish is required [where indicated on the drawings] [in the following areas, [_____].] Fins, ravelings, and loose material shall be removed, all surface defects over 1/2 inch in diameter or more than 1/2 inch deep, shall be repaired and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be reamed and filled. Defects more than 1/2 inch in diameter shall be cut back to sound concrete, but in all cases at least 1 inch deep. The Contractor shall prepare a sample panel for approval (as specified in PART 1) before commencing repair, showing that the surface texture and color match will be attained. Metal tools shall not be used to finish repairs in Class A surfaces.

3.10.2 Class C and Class D Finish

Class C finish is required [where indicated on the drawings.] [in the following areas, [_____].] Class D finish is required [where indicated on the drawings.] [in the following areas, [_____].] Fins, ravelings, and loose material shall be removed, and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be reamed and filled. Honeycomb and other defects more than 1/2 inch deep or more than 2 inches in diameter shall be repaired. Defects more than 2 inches in diameter shall be cut back to sound concrete, but in all cases at least 1 inch deep.

3.10.3 Architectural and Special Finishes

****
NOTE: The specification writer must ensure that any areas to receive architectural and special finishes are indicated on the drawings or specified in Section 03330 CAST-IN-PLACE ARCHITECTURAL CONCRETE or herein. Where these paragraphs require a finish to match a sample panel on display during the bidding period, the specification writer must ensure that such panel is fabricated and displayed. When considered appropriate, require a test panel to be fabricated for approval before start of construction.
****

Architectural concrete finishes are specified in Section 03330CAST-IN-PLACE ARCHITECTURAL CONCRETE. Special finishes shall conform to the requirements specified herein.

3.10.3.1 Smooth Finish

After other concrete construction is complete in each overall separate contiguous area of the structure, smooth finish shall be applied to [the areas indicated on the drawings] [the following areas, [_____]]. A mortar mix consisting of one part portland cement and two parts well-graded sand passing a No. 30 sieve, with water added to give the consistency of thick paint, shall be used. Where the finished surface will not receive other applied surface, white cement shall be used to replace part of the job cement to produce an approved color, which shall be uniform throughout the surfaces of the structure. After the surface has been thoroughly wetted and allowed to approach surface dryness, the mortar shall be vigorously applied to the area by clean burlap pads or by cork or wood-floating, to completely fill all surface voids. Excess grout shall be scraped off with a trowel. As soon as it can be accomplished without pulling the mortar from the voids, the area shall be rubbed with burlap pads having on their surface the same sand-cement mix specified above but without any mixing water, until all of the visible grout film is removed. The burlap pads used for this operation shall be stretched tightly around a board to prevent dishing the mortar in the voids. The finish of any area shall be completed in the same day, and the limits of a finished area shall be made at natural breaks in the surface. The surface shall be continuously moist cured for 48 hours commencing immediately after finishing operations in each area. The temperature of the air adjacent to the surface shall be not less than 50 degrees F for 24 hours prior to, and 48 hours after, the application. In hot, dry weather the smooth finish shall be applied in shaded areas or at night, and shall never be applied when there is significant hot, dry wind.

3.10.3.2 Exposed Coarse-Aggregate Finish

Coarse aggregate shall consist of [_____] material, shall meet the specified quality requirements, and shall have a grading as follows: [_____]. Coarse aggregate shall be exposed by an approved method. The finish shall be similar to and shall closely match the finish on the sample panel put on display during the bidding period, and the finish on the approved preconstruction test panel fabricated by the Contractor.

3.10.3.3 Sandblast Finish

The concrete surface shall be blasted at an approved age with approved wet sandblasting procedures to obtain a [brush] [light] [medium] [heavy] finish which will match the descriptive photographs in ACI 303R. The finish shall be similar to and shall closely match the finish on the approved preconstruction test panel fabricated by the Contractor.

3.10.3.4 Tooled Finish

The thoroughly cured concrete shall be dressed at an approved age with approved electric, air, or hand tools to a uniform texture with a [hand-tooled] [rough] [fine-pointed] [crandalled] [or] [bush-hammered] surface texture. The finish shall be similar to and shall closely match the finish on the approved preconstruction test panel fabricated by the Contractor.

3.11 REPAIRS

3.11.1 Damp-Pack Mortar Repair

Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter but not over 4 inchesshall be repaired by the damp-pack mortar method. Form tie holes shall be reamed and other similar defects shall be cut out to sound concrete. The void shall then be thoroughly cleaned, thoroughly wetted, brush-coated with a thin coat of neat cement grout and filled with mortar. Mortar shall be a stiff mix of 1 part portland cement to 2 parts fine aggregate passing the No. 16 mesh sieve, and minimum amount of water. Only sufficient water shall be used to produce a mortar which, when used, will stick together on being molded into a ball by a slight pressure of the hands and will not exude water but will leave the hands damp. Mortar shall be mixed and allowed to stand for 30 to 45 minutes before use with remixing performed immediately prior to use. Mortar shall be thoroughly tamped in place in thin layers using a hammer and hardwood block. Holes passing entirely through walls shall be completely filled from the inside face by forcing mortar through to the outside face. All holes shall be packed full. Damp-pack repairs shall be moist cured for at least 48 hours.

3.11.2 Repair of Major Defects

Major defects will be considered to be those more than 1/2 inch deep or, for Class A and B finishes, more than 1/2 inch in diameter and, for Class C and D finishes, more than 2 inches in diameter. Also included are any defects of any kind whose depth is over 4 inches or whose surface diameter is greater than their depth. Major defects shall be repaired as specified below.

3.11.2.1 Surface Application of Mortar Repair

Defective concrete shall be removed, and removal shall extend into completely sound concrete. Approved equipment and procedures which will not cause cracking or microcracking of the sound concrete shall be used. If reinforcement is encountered, concrete shall be removed so as to expose the reinforcement for at least 2 inches on all sides. All such defective areas greater than 12 square inchesshall be outlined by saw cuts at least 1 inch deep. Defective areas less than 12 square inches shall be outlined by a 1 inch deep cut with a core drill in lieu of sawing. All saw cuts shall be straight lines in a rectangular pattern in line with the formwork panels. After concrete removal, the surface shall be thoroughly cleaned by high pressure washing to remove all loose material. Surfaces shall be kept continually saturated for the first 12 of the 24 hours immediately before placing mortar and shall be damp but not wet at the time of commencing mortar placement. The Contractor, at his option, may use either hand-placed mortar or mortar placed with a mortar gun. If hand-placed mortar is used, the edges of the cut shall be perpendicular to the surface of the concrete. The prepared area shall be brush-coated with a thin coat of neat cement grout. The repair shall then be made using a stiff mortar, preshrunk by allowing the mixed mortar to stand for 30 to 45 minutes and then remixed, thoroughly tamped into place in thin layers. If hand-placed mortar is used, the Contractor shall test each repair area for drumminess by firm tapping with a hammer and shall inspect for cracks, both in the presence of the Contracting Officer's representative, immediately before completion of the contract, and shall replace any showing drumminess or cracking. If mortar placed with a mortar gun is used, the gun shall be a small compressed air-operated gun to which the mortar is slowly hand fed and which applies the mortar to the surface as a high-pressure stream, as approved. Repairs made using shotcrete equipment will not be accepted. The mortar used shall be the same mortar as specified for damp-pack mortar repair. If gun-placed mortar is used, the edges of the cut shall be beveled toward the center at a slope of 1:1. All surface applied mortar repairs shall be continuously moist cured for at least 7 days. Moist curing shall consist of several layers of saturated burlap applied to the surface immediately after placement is complete and covered with polyethylene sheeting, all held closely in place by a sheet of plywood or similar material rigidly braced against it. Burlap shall be kept continually wet.

3.11.2.2 Repair of Deep and Large Defects

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NOTE: Use this paragraph only for areas where the designer considers this degree of repair acceptable; otherwise require removal and replacement of concrete containing these types of defects.

****

Deep and large defects will be those that are more than 6 inches deep and also have an average diameter at the surface more than 18 inches or that are otherwise so identified by the Project Office. Such defects shall be repaired as specified herein or directed, except that defects which affect the strength of the structure shall not be repaired and that portion of the structure shall be completely removed and replaced. Deep and large defects shall be repaired by procedures approved in advance including forming and placing special concrete using applied pressure during hardening. Preparation of the repair area shall be as specified for surface application of mortar. In addition, the top edge (surface) of the repair area shall be sloped at approximately 20 degrees from the horizontal, upward toward the side from which concrete will be placed. The special concrete shall be a concrete mixture with low water content and low slump, and shall be allowed to age 30 to 60 minutes before use. Concrete containing a specified expanding admixture may be used in lieu of the above mixture; the paste portion of such concrete mixture shall be designed to have an expansion between 2.0 and 4.0 percent when tested in accordance with ASTM C 940. A full width "chimney" shall be provided at the top of the form on the placing side to ensure filling to the top of the opening. A pressure cap shall be used on the concrete in the chimney with simultaneous tightening and revibrating the form during hardening to ensure a tight fit for the repair. The form shall be removed after 24 hours and immediately the chimney shall be carefully chipped away to avoid breaking concrete out of the repair; the surface of the repair concrete shall be dressed as required.

3.11.3 Resinous and Latex Material Repair

****

NOTE: The portland cement type repairs specified above are considered appropriate for usual repairs. The designer should use the materials specified herein only if there is a record of previous successful use or if the use has been discussed in detail with the Waterways Experiment Station (CEWES-SL-EP). Additional requirements for their use must be added. Color match may be a problem with this type of repair.

****

In lieu of the portland cement [bonding coats specified above, an epoxy resin or a latex bonding agent may be used.] [based mortars specified above, an epoxy resin mortar based on epoxy resin or a mortar based on latex bonding agent may be used in the following specific locations [_____].] The following additional requirements shall be met in the use of these materials [_____].

3.12 FINISHING UNFORMED SURFACES

****

NOTE: Type of finish of unformed surfaces should be indicated on the drawings. If not on the drawings, it must be specified here. Correlate this paragraph with paragraph Tolerances in PART 1 and ACI 117/117R.

****

The finish of all unformed surfaces shall meet the requirements of paragraph Tolerances in PART 1, when tested as specified herein.

3.12.1 General

The ambient temperature of spaces adjacent to unformed surfaces being finished and of the base on which concrete will be placed shall be not less than 50 degrees F. In hot weather all requirements of paragraphs Hot Weather Requirements and Prevention of Plastic Shrinkage Cracking shall be met. Unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish, with additional finishing as specified below, and shall be true to the elevation shown on the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown on the drawings, properly consolidated, and left true and regular. Unless otherwise shown on the drawings, exterior surfaces shall be sloped for drainage, as directed. Where drains are provided, interior floors shall be evenly sloped to the drains. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. Grate tampers or "jitterbugs" shall not be used for any surfaces. The dusting of surfaces with dry cement or other materials or the addition of any water during finishing shall not be permitted. If bleedwater is present prior to finishing, the excess water shall be carefully dragged off or removed by absorption with porous materials such as burlap. During finishing operations, extreme care shall be taken to prevent over finishing or working water into the surface; this can cause "crazing" (surface shrinkage cracks which appear after hardening) of the surface. Any slabs with surfaces which exhibit significant crazing shall be removed and replaced. During finishing operations, surfaces shall be checked with a 10 foot straightedge, applied in both directions at regular intervals while the concrete is still plastic, to detect high or low areas.

3.12.2 Rough Slab Finish

****

NOTE: Rough-slab finish alone is used when a bonded surface course for heavy use industrial floor is specified, or where roof fill or thick mortar setting bed is used. If the drawings do not indicate the slabs to receive only a rough slab finish, they must be specified here. Rough slab finish must be retained as the first operation for all subsequent finishing.

****

As a first finishing operation for unformed surfaces and as final finish for slabs to receive mortar setting beds, the surface shall receive a rough slab finish prepared as follows. [Areas indicated on the drawings] [The following areas [_____]] shall receive only a rough slab finish. The concrete shall be uniformly placed across the slab area, consolidated as previously specified, and then screeded with straightedge strikeoffs immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible. Side forms and screed rails shall be provided, rigidly supported, and set to exact line and grade. Allowable tolerances for finished surfaces apply only to the hardened concrete, not to forms or screed rails. Forms and screed rails shall be set true to line and grade. "Wet screeds" shall not be used.

3.12.3 Floated Finish

****

NOTE: If the drawings do not indicate the areas to receive a floated finish, they must be specified here.

****

Slabs to receive more than a rough slab finish shall next be given a wood float finish. [Areas as indicated on the drawings] [The following areas [_____]] shall be given only a float finish. The screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. Then, after the concrete has stiffened so that it will withstand a man's weight without imprint of more than 1/4 inch and the water sheen has disappeared, it shall be floated to a true and even plane free of ridges. Floating shall be performed by use of suitable hand floats or power driven equipment. Sufficient pressure shall be used on the floats to bring a film of moisture to the surface. Hand floats shall be made of wood, magnesium, or aluminum. Lightweight concrete or concrete that exhibits stickiness shall be floated with a magnesium float. Care shall be taken to prevent over-finishing or incorporating water into the surface.

3.12.4 Troweled Finish

****

NOTE: If the drawings do not indicate the areas to receive a trowel finish, they must be specified here. Edit accordingly. A troweled finish will be specified for most wearing surfaces and where a smooth dense surface finish is required. Edit bracketed items as desired by designer. Delete this paragraph when no troweled finish or subsequent finish is required.

****

[Areas as indicated on the drawings] [The following areas [_____]] shall be given a trowel finish. After floating is complete and after the surface moisture has disappeared, unformed surfaces shall be steel-troweled to a smooth, even, dense finish, free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. Additional trowelings shall be performed, either by hand or machine until the surface has been troweled [2] [3] [4] times, with waiting period between each. Care shall be taken to prevent blistering and if such occurs, troweling shall immediately be stopped and operations and surfaces corrected. A final hard steel troweling shall be done by hand, with the trowel tipped, and using hard pressure, when the surface is at a point that the trowel will produce a ringing sound. The finished surface shall be thoroughly consolidated and shall be essentially free of trowel marks and be uniform in texture and appearance. The concrete mixture used for troweled finished areas shall be adjusted, if necessary, in order to provide sufficient fines (cementitious material and fine sand) to finish properly.

3.12.5 Superflat Finish

****

NOTE: If the drawings do not indicate the areas to receive a superflat surface, they must be specified here. Correlate this paragraph with the "Tolerances" paragraph in PART 1. Primary locations where superflat floors are required are warehouse aisles where very high lift forklifts and other type stackers operate. Delete this paragraph when superflat finish is not required.

****

[Areas as indicated on the drawings] [The following areas [_____]] shall be constructed as superflat floors. Extreme care shall be taken to meet specified tolerances. If necessary, special heavy duty, laser guided machines built especially for this work shall be used and shall have experienced, factory-trained operators. Finishing operations shall include use of long-handled 10 foot "highway type" cutting straightedges plus any other tools necessary to meet the surface tolerance requirements. Surface finish shall conform to paragraph [Troweled Finish] [_____].

3.12.6 Non-Slip Finish

****

NOTE: If drawings do not indicate the areas to receive non-slip finish, they must be specified here. Broom finish is usually used for exterior slabs and abrasive aggregate for interior slabs, but

such policy is not definite. Edit bracketed items as appropriate. Delete these paragraphs when Non-Slip Finish is not required.

****

Non-slip floors shall be constructed in accordance with the following subparagraphs.

3.12.6.1 Broomed

[Areas as indicated on the drawings] [The following areas [_____]] shall be given a broomed finish. After floating, the surface shall be lightly steel troweled, and then carefully scored by pulling a [hair] [coarse fiber] push-type broom across the surface. Brooming shall be transverse to traffic or at right angles to the slope of the slab. After the end of the curing period, the surface shall be vigorously broomed with a coarse fiber broom to remove all loose or semi-detached particles.

3.12.6.2 Abrasive Aggregate

[Areas as indicated on the drawings] [The following areas [_____]] shall be given an abrasive aggregate finish. The concrete surface shall be given a float finish. Abrasive aggregate shall then immediately be uniformly sprinkled over the floated surface at a total rate of not less than 0.25 psf spread in two applications at right angles to each other. The surface shall then be troweled to a smooth, even finish that is uniform in texture and appearance and free from blemishes including trowels marks. Immediately after curing, cement paste and laitance covering the abrasive aggregate shall be removed by steel brushing, rubbing with abrasive stone, or sandblasting to expose the abrasive particles.

3.12.7 Dry Shake Finish

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NOTE: If the drawings do not indicate the areas to receive a dry shake finish, they must be specified here. When dry shake finish is required, add to paragraph Technical Service for Specialized Concrete a requirement that a manufacturer's representative be present during use of dry shake finish.

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[Areas as indicated on the drawings] [The following areas [_____]] shall be constructed with a dry shake finish. [Dry shake floor armoring topping] [Dry shake conductive and spark resistant floor topping] [Dry shake non-metallic, light reflective floor topping] shall be used to surface the floor. The base slab shall be constructed and the dry shake material applied in accordance with the manufacturer's written instructions, which shall be furnished by the Contractor. The dry shake material shall be applied in a two-stage application. Total application shall be at the rate recommended by the manufacturer but at a rate not less than 1.5 psf. The first application shall be at the rate of two-thirds of the total and shall be applied immediately following floating of total area. The dry shake material shall first be applied to the floated concrete adjacent to forms, entryways, columns, and walls where moisture will be lost first. Dry shake material shall be distributed evenly using an approved mechanical spreader. The material shall not be hand thrown on the surface. Finishing machines with float shoes shall be used as soon as dry shake has absorbed moisture (indicated by darkening of surface); floating shall be done just sufficiently to bring moisture from base slab through the shake. Immediately following floating of the first shake, the remaining one-third of the total specified shake shall be applied in the same manner and machine floated. Surface shall be further compacted by a third mechanical floating if time and setting characteristics will allow. At no time shall water be added to the surface. As surface further stiffens, indicated by loss of sheen, it shall be hand or mechanically troweled with blades relatively flat. All marks and pinholes shall be removed in the final raised trowel operation. Floors finished with dry shake material shall be cured using a curing compound recommended by the manufacturer of the dry shake material. Membrane curing compound shall be applied immediately after the floor surface has hardened sufficiently so surface will not be marred by the application. Compound shall be applied uniformly over the entire surface at a coverage which will provide moisture retention in excess of the requirements of ASTM C 309. When dry, the coating shall be protected from droppings of plaster, paint, dirt, and other debris by a covering of scuffproof, non-staining building paper. Floor shall remain covered and be kept free of traffic and loads for at least 10 days after completion. Adequate provision shall be made for maintaining the concrete temperature at 50 degrees F or above during the curing period. The curing compound shall remain in place for not less than 30 days. The curing compound shall be removed by a manufacturer recommended method prior to turning the facility over to the Government.

3.12.8 Heavy Duty Floors

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NOTE: Heavy duty floors are to be used only for floors that will receive major traffic of tracked vehicles or steel wheeled equipment when the designer is concerned about wear. Moderate amounts of such traffic can be accommodated by ordinary concrete floors. If drawings do not indicate areas to receive heavy duty finish, they must be specified here. Delete this subparagraph if not required. Edit bracketed items. Add to and strengthen this subparagraph as needed but do not delete any of the listed requirements.
****

[Areas as indicated on the drawings] [The following areas [_____]] shall have heavy duty floors constructed as follows:

3.12.8.1 General

Heavy duty floor shall be constructed by placing a heavy duty bonded topping on a base slab which has had a rough slab finish left 2 inches below final grade. Concrete in the base slab shall be thoroughly hardened but not more than 30 hours old. The temperature of the fresh concrete topping shall not vary more than 10 degrees Fplus or minus from the temperature of the base slab. The ambient temperature of the space adjacent to the concrete placement and of the base slab shall be between 50 and 90 degrees F.

3.12.8.2 Preparation of Base Slab

The base slab shall be kept continuously damp until topping is placed. The surface of the base slab shall be thoroughly cleaned with an air-water jet immediately before placing the topping. A thin coat of neat cement grout of about the consistency of thick cream shall be thoroughly scrubbed into the existing surface immediately ahead of the overlay placing. At the time the neat cement grout is placed, the existing concrete surface shall be damp but shall have no free water present. The overlay concrete shall be deposited before the grout coat has had time to stiffen.

3.12.8.3 Placing and Finishing

Concrete shall be placed, as nearly as practicable in final position, in a uniform layer. The overlay shall be placed and screeded slightly above the required finished grade, compacted by rolling with rollers weighing not less than 10 pounds per linear 1 inch of roller width or by approved tamping equipment and finish screeded to established grade. Grid type tampers shall not be used. The concrete, while still green but sufficiently hardened to bear a person's weight without deep imprint, shall be floated to a true even plane with no coarse aggregate visible. Floating shall be performed with an approved disc-type mechanical float which has integral impact mechanism. The surface of the overlay shall then be left undisturbed until the concrete has hardened enough to prevent excess fines from being worked to the top. Joints shall be formed to match those in the base slab.

3.12.8.4 Curing and Protection

Concrete shall be maintained in a moist condition and shall be protected against rapid temperature change, mechanical injury, and injury from rain or flowing water, for a curing period of not less than 10 days. Concrete shall be maintained in a moist condition at temperatures above 50 and below 90 degrees F throughout the specified curing period. Concrete shall be protected from a temperature change greater than 5 degrees F per hour and from rapid drying for the first 24 hours following the removal of temperature protection. Curing activities shall begin as soon as free water has disappeared from the concrete surface after placing and finishing. Curing shall be moist curing accomplished by the following method. Surfaces shall be covered with a double layer of burlap, wetted before placing, and overlapped at least 6 inches. Burlap shall be kept continually wet and in intimate contact with the surface. Burlap shall be kept covered with a polyethylene sheeting at least 4 milsthick. All traffic shall be kept from the floor during the curing period and heavy traffic shall be kept off till 28-day age.

3.12.9 Two-Course Floor Construction

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NOTE: Where it is anticipated that the surface of a floor slab may be damaged during construction operations, a two-course floor may be specified with the second course applied late in the contract. If the drawings do not indicate areas to receive two-course floor construction, they must be specified here. Delete this subparagraph when two-course floor is not required. Edit bracketed items.

****

[Areas as indicated on the drawings] [The following areas [_____]] shall have floors constructed with two-course construction. Two-course floor shall be constructed by placing a bonded topping on the thoroughly hardened concrete base slab which has been left with a rough slab finish left 2 inches below final grade as shown on the drawings. Topping shall be applied at an approved time late in the contract period. The floor topping mixture shall have a specified compressive strength of 5000 psi at 28 days, a 2 inch maximum slump, 1/2 inch maximum size coarse aggregate, and shall be proportioned to obtain required finishability. The surface of the base slab shall be thoroughly cleaned by sandblasting or high-pressure waterjet immediately before placing topping. The temperature of the fresh concrete topping shall not vary more than 10 degrees F plus or minus from the temperature of the base slab. The ambient temperature of the space adjacent to the concrete placement and of the base slab shall be between 50 and 90 degrees F. The base slab shall be kept continuously wet for the first 12 hours during the 24 hour period immediately prior to placing the finished floor. After all free water has evaporated or has been removed from the surface, a grout shall be scrubbed in. The grout shall be a 1:1 mixture of portland cement and sand passing the No. 8 sieve mixed to a creamlike consistency. The grout shall be scrubbed into the surface just ahead of the concrete topping placing operation. While the grout is still damp, the top course shall be spread and screeded and darbied or bull floated. When the surface moisture has disappeared, the surface shall then be floated with disc-type power float with integral impact mechanism followed by a minimum of two power trowelings. Trowel marks left by the machine shall be removed by a final, hard steel troweling by hand. Joints shall be formed to match those in the base slab. Concrete shall be maintained in a moist condition and shall be protected against rapid temperature change, mechanical injury, and injury from rain or water, for a curing period of not less than 10 days. Concrete shall be maintained in a moist condition at temperatures above 50 and below 90 degrees F throughout the specified curing period. Concrete shall be protected from a temperature change greater than 5 degrees F per hour and from rapid drying for the first 24 hours following the removal of temperature protection. Curing activities shall be started immediately as soon as free water has disappeared from the surface of the concrete after placing and finishing. Curing shall be moist curing accomplished by the following method. Surfaces shall be covered with a double layer of burlap, wetted before placing, and overlapped at least 6 inches. Burlap shall be kept continually wet and in intimate contact with the surface. Burlap shall be kept covered with a polyethylene sheeting at least 4 mils thick. All traffic shall be kept from the topping during the curing period.

3.13 FLOOR HARDENER

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NOTE: If the drawings do not indicate the areas to receive floor hardener, they must be specified here. Normally, floor hardener is not needed. Use only where extreme dust-free area is required or where requested by using service.

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[Areas as indicated on the drawings] [The following areas [_____]] shall be treated with floor hardener. Floor hardener shall be applied after the concrete has been cured and then air dried for [14] [28] days. Three coats shall be applied, each the day after the preceding coat was applied. For the first application, one pound of the silocofluoride shall be dissolved in one gallon of water. For subsequent applications, the solution shall be two pounds of silicofluoride to each gallon of water. Floor should be mopped with clear water shortly after the preceding application has dried to remove encrusted salts. Proprietary hardeners shall be applied in accordance with the manufacturer's instructions. During application, area should be well ventilated. Precautions shall be taken when applying silicofluorides due to the toxicity of the salts. Any compound that contacts glass or aluminum should be immediately removed with clear water.

3.14 EXTERIOR SLAB AND RELATED ITEMS

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NOTE: Edit bracketed statements and use these paragraphs only when minor amounts of specified items are required in the project. Remove affected paragraph when pertinent Section (Ex: 02513 CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER HEAVY-DUTY PAVEMENTS, 02511 CONCRETE SIDEWALKS AND CURBS AND GUTTERS) is included in the contract.

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3.14.1 Pavements

Pavements shall be constructed where shown on the drawings. After forms are set and underlying material prepared as specified, the concrete shall be placed uniformly throughout the area and thoroughly vibrated. As soon as placed and vibrated, the concrete shall be struck off and screeded to the crown and cross section and to such elevation above grade that when consolidated and finished, the surface of the pavement will be at the required elevation. The entire surface shall be tamped with the strike off, or consolidated with a vibrating screed, and this operation continued until the required compaction and reduction of internal and surface voids are accomplished. Care shall be taken to prevent bringing excess paste to the surface. Immediately following the final consolidation of the surface, the pavement shall be floated longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, additional concrete shall be placed and screeded, and the float operated until a satisfactory surface has been produced. The floating operation shall be advanced not more than half the length of the float and then continued over the new and previously floated surfaces. After finishing is completed but while the concrete is still plastic, minor irregularities and score marks in the pavement surface shall be eliminated by means of long-handled cutting straightedges. Straightedges shall be 12 feet in length and shall be operated from the sides of the pavement and from bridges. A straightedge operated from the side of the pavement shall be equipped with a handle 3 feet longer than one-half the width of the pavement. The surface shall then be tested for trueness with a 12 foot straightedge held in successive positions parallel and at right angles to the center line of the pavement, and the whole area covered as necessary to detect variations. The straightedge shall be advanced along the pavement in successive stages of not more than one-half the length of the straightedge. Depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. Projections above the required elevation shall also be struck off and refinished. The straightedge testing and finishing shall continue until the entire surface of the concrete is true. Before the surface sheen has disappeared and well before the concrete becomes nonplastic, the surface of the pavement shall be given a nonslip sandy surface texture by [belting with approved "belt" and procedures] [use of a burlap drag. A strip of clean, wet burlap from 3 to 5 feet wide and 2 feet longer than the pavement width shall be carefully pulled across the surface]. Edges and joints shall be rounded with an edger having a radius of 1/8 inch. Curing shall be as specified.

3.14.2 Sidewalks

Concrete shall be 4 inches minimum thickness. Contraction joints shall be provided at 5 feet spaces unless otherwise indicated. Contraction joints shall be cut 1 inch deep with a jointing tool after the surface has been finished. Transverse expansion joints 1/2 inch thick shall be provided at changes in direction and where sidewalk abuts curbs, steps, rigid pavement, or other similar structures. Sidewalks shall be given a lightly broomed finish. A transverse slope of 1/4 inch per foot shall be provided, unless otherwise indicated. Variations in cross section shall be limited to 1/4 inch in 5 feet.

3.14.3 Curbs and Gutters

Concrete shall be formed, placed, and finished by hand using a properly shaped "mule" or constructed using a slipform machine specially designed for this work. Contraction joints shall be cut 3 inches deep with a jointing tool after the surface has been finished. Expansion joints (1/2 inch wide) shall be provided at 100 feetmaximum spacing unless otherwise indicated. Exposed surfaces shall be finished using a stiff bristled brush.

3.14.4 Pits and Trenches

Pits and trenches shall be constructed as indicated on the drawings. Bottoms and walls shall be placed monolithically or waterstops and keys, shall be provided as approved.

3.15 CURING AND PROTECTION

3.15.1 General

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NOTE: Do not allow membrane curing compound on surfaces where appearance is critical or that are maintained at curing temperature with free steam. Moist curing should almost always be permitted.

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Concrete shall be cured by an approved method for the period of time given below:

Concrete with Type III cement	3 days
All other concrete	7 days

Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, mechanical injury and damage from rain and flowing water for the duration of the curing period. Air and forms in contact with concrete shall be maintained at a temperature above 50 degrees F for the first 3 days and at a temperature above 32 degrees F for the remainder of the specified curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure, and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards. Materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat, including welding, shall be permitted near or in direct contact with the concrete at any time. Except as otherwise permitted by paragraph Membrane Forming Curing Compounds, moist curing shall be provided for any areas to receive floor hardener, any paint or other applied coating, or to which other concrete is to be bonded. Concrete containing silica fume shall be initially cured by fog misting during finishing, followed immediately by continuous moist curing. Except for plastic coated burlap, impervious sheeting alone shall not be used for curing.

3.15.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period, commencing immediately after finishing. If water or curing materials used stain or discolor concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned as approved. When wooden forms are left in place during curing, they shall be kept wet at all times. If steel forms are used in hot weather, nonsupporting vertical forms shall be broken loose from the concrete soon after the concrete hardens and curing water continually applied in this void. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Surfaces shall be cured by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Burlap and mats shall be clean and free from any contamination and shall be completely saturated before being placed on the concrete. The Contractor shall have an approved work system to ensure that moist curing is continuous 24 hours per day.

3.15.3 Membrane Forming Curing Compounds

Membrane forming curing compounds shall be used only on surfaces in the following areas, [_____]. Concrete in the following areas [may be cured with a pigmented curing compound in lieu of moist curing.] [may be cured with a nonpigmented curing compound containing a fugitive dye in lieu of moist curing.] Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete, including surfaces to which a smooth finish is to be applied or other concrete to be bonded. However, a styrene acrylate or chlorinated rubber compound meeting ASTM C 309, Class B requirements, may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. All surfaces shall be thoroughly moistened with water. Curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. The curing compound shall be applied in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 75 psi, at a uniform coverage of not more than 400 square feet per gallon for each coat, and the second coat shall be applied perpendicular to the first coat. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. Surfaces on which clear compound is used shall be shaded from direct rays of the sun for the first 3 days. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3.15.4 Impervious Sheeting

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NOTE: Use impervious sheeting only for surfaces that are horizontal or near horizontal. Do not use on slab surfaces where appearance is critical.

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The following concrete surfaces may be cured using impervious sheets: [_____]. However, except for plastic coated burlap, impervious sheeting alone shall not be used for curing. Impervious-sheet curing shall only be used on horizontal or nearly horizontal surfaces. Surfaces shall be thoroughly wetted and be completely covered with the sheeting. Sheeting shall be at least 18 inches wider than the concrete surface to be covered. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 12 inches and securely weighted down or shall be lapped not less than 4 inches and taped to form a continuous cover with completely closed joints. The sheet shall be weighted to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

3.15.5 Ponding or Immersion

Concrete shall be continually immersed throughout the curing period. Water shall not be more than 20 degrees F less than the temperature of the concrete.

3.15.6 Cold Weather Curing and Protection

When the daily ambient low temperature is less than 32 degrees F the temperature of the concrete shall be maintained above 40 degrees F for the first seven days after placing. During the period of protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the surface will not be subjected to a temperature differential of more than 25 degrees F as determined by suitable temperature measuring devices furnished by the Government, as required, and installed adjacent to the concrete surface and 2 inches inside the surface of the concrete. The installation of the thermometers shall be made by the Contractor as directed.

3.16 SETTING BASE PLATES AND BEARING PLATES

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NOTE: Damp-pack bedding mortar will be specified for setting base and bearing plates, except that nonshrink grout will be specified for heavy machinery bases or where design requires precision setting of plates or requires that bedding material have high resistance to shear, impact, or vibration, and where good damp packing is difficult or impossible. When using nonshrink grout on important structures, such as large machinery bases, the grout

should be required to meet ASTM C 1107, Grade A, B, or C, grade or grades as selected by the designer. This nonshrink grout must not be used for embedding post-tensioned tendons or rock bolts. Edit bracketed item as appropriate, and delete entire paragraph if not needed.

****

After being properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be set to the proper line and elevation with damp-pack bedding mortar, except where nonshrink grout is indicated. The thickness of the mortar or grout shall be approximately 1/24 the width of the plate, but not less than 3/4 inch. Concrete and metal surfaces in contact with grout shall be clean and free of oil and grease, and concrete surfaces in contact with grout shall be damp and free of laitance when grout is placed. Nonshrink grout shall be used for [_____].

3.16.1 Damp-Pack Bedding Mortar

Damp-pack bedding mortar shall consist of 1 part cement and 2-1/2 parts fine aggregate having water content such that a mass of mortar tightly squeezed in the hand will retain its shape but will crumble when disturbed. The space between the top of the concrete and bottom of the bearing plate or base shall be packed with the bedding mortar by tamping or ramming with a bar or rod until it is completely filled.

3.16.2 Nonshrink Grout

Nonshrink grout shall be a ready-mixed material requiring only the addition of water. Water content shall be the minimum that will provide a flowable mixture and completely fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.16.2.1 Mixing and Placing of Nonshrink Grout

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified therein. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. The space between the top of the concrete or machinery-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for completely retaining the grout on all sides and on top and shall be removed after the grout has set. The placed grout shall be carefully worked by rodding or other means to eliminate voids; however, overworking and breakdown of the initial set shall be avoided. Grout shall not be retempered or subjected to vibration from any source. Where clearances are unusually small, placement shall be under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 65 to 85 degrees F until after setting.

3.16.2.2 Treatment of Exposed Surfaces

For metal-oxidizing nonshrink grout, exposed surfaces shall be cut back 1 inch and immediately covered with a parge coat of mortar consisting of 1 part portland cement and 2-1/2 parts fine aggregate by weight, with sufficient water to make a plastic mixture. The parge coat shall have a smooth finish. For other mortars or grouts, exposed surfaces shall have a smooth-dense finish and be left untreated. Curing shall comply with paragraph CURING AND PROTECTION.

3.17 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL

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NOTE: For non-critical small projects, less than 1200 cubic meters (1500 cu. yd.) of concrete, the designer may reduce, but not eliminate, the requirements of this paragraph, and edit it appropriately for the project specifications. Otherwise, retain complete.

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The Contractor shall perform the inspection and tests described below and, based upon the results of these inspections and tests, shall take the action required and shall submit specified reports. When, in the opinion of the Contracting Officer, the concreting operation is out of control, concrete placement shall cease and the operation shall be corrected. The laboratory performing the tests shall be onsite and shall conform with ASTM C 1077. Materials may be subjected to check testing by the Government from samples obtained at the manufacturer, at transfer points, or at the project site. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per [_____] thereafter for conformance with ASTM C 1077.

3.17.1 Grading and Corrective Action

3.17.1.1 Fine Aggregate

At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C 136 and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately reported to the Contracting Officer, concreting shall be stopped, and immediate steps taken to correct the grading.

3.17.1.2 Coarse Aggregate

At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of 5 tests are outside specification limits, the operation shall be considered out of control and shall be reported to the Contracting Officer. Concreting shall be stopped and immediate steps shall be taken to correct the grading.

3.17.2 Quality of Aggregates

Thirty days prior to the start of concrete placement, the Contractor shall perform all tests for aggregate quality required by ASTM C 33. In addition, after the start of concrete placement, the Contractor shall perform tests for aggregate quality at least every three months, and when the source of aggregate or aggregate quality changes. Samples tested after the start of concrete placement shall be taken immediately prior to entering the concrete mixer.

3.17.3 Scales, Batching and Recording

The accuracy of the scales shall be checked by test weights prior to start of concrete operations and at least once every three months. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors. Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. At the same time, the Contractor shall test and ensure that the devices for dispensing admixtures are operating properly and accurately. When either the weighing accuracy or batching accuracy does not comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

3.17.4 Batch-Plant Control

The measurement of concrete materials including cementitious materials, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate weights and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. The amount of air-entraining agent shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic yard, amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic yard for each class of concrete batched during each day's plant operation.

3.17.5 Concrete Mixture

a. Air Content Testing. Air content tests shall be made when test specimens are fabricated. In addition, at least two tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Tests shall be made in accordance with ASTM C 231 for normal weight concrete and ASTM C 173 for lightweight concrete. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single test result reaches either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the air content of the batch to plot on both the air content and the control chart for range, and for determining need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate control chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph Air Entrainment. An upper warning limit and a lower warning limit line shall be set 1.0 percentage point above and below the average line, respectively. An upper action limit and a lower action limit line shall be set 1.5 percentage points above and below the average line, respectively. The range between each two consecutive tests shall be plotted on a secondary control chart for range where an upper warning limit is set at 2.0 percentage points and an upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content. If the Contractor's materials or transportation methods cause air content loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the air content at the mixer controlled as directed.

b. Air Content Corrective Action. Whenever points on the control chart for percent air reach either warning limit, an adjustment shall immediately be made in the amount of air-entraining admixture batched. As soon as practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the secondary control chart for range reaches the warning limit, the admixture dispenser shall be recalibrated to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content shall be considered out of control and the concreting operation shall immediately be halted until the air content is under control. Additional air content tests shall be made when concreting is restarted.

c. Slump Testing. In addition to slump tests which shall be made when test specimens are fabricated, at least four slump tests shall be made on randomly selected batches in accordance with ASTM C 143 for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the slump of the batch to plot on both the control charts for slump and the chart for range, and for determining need for any remedial action. Limits shall be set on separate control charts for slump for each type of mixture.

The upper warning limit shall be set at 1/2 inch below the maximum allowable slump specified in paragraph Slump in PART 1 for each type of concrete and an upper action limit line and lower action limit line shall be set at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. The range between each consecutive slump test for each type of mixture shall be plotted on a single control chart for range on which an upper action limit is set at 2 inches. Samples for slump shall be taken at the mixer. However, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the slump at the mixer controlled as directed.

d. Slump Corrective Action. Whenever points on the control charts for slump reach the upper warning limit, an adjustment shall immediately be made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount allowed by the maximum w/c ratio specified, based on aggregates which are in a saturated surface dry condition. When a single slump reaches the upper or lower action limit, no further concrete shall be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive individual slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, the concreting operation shall immediately be halted, and the Contractor shall take appropriate steps to bring the slump under control. Additional slump tests shall be made as directed.

e. Temperature. The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064. The temperature shall be reported along with the compressive strength data.

f. Strength Specimens. At least one set of test specimens shall be made, for compressive or flexural strength as appropriate, on each different concrete mixture placed during the day for each 500 cubic yards or portion thereof of that concrete mixture placed each day. Additional sets of test specimens shall be made, as directed by the Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. A truly random (not haphazard) sampling plan shall be developed by the Contractor and approved by the Contracting Officer prior to the start of construction. The plan shall assure that sampling is done in a completely random and unbiased manner. A set of test specimens for concrete with a 28-day specified strength per paragraph Strength Requirements in PART 1 shall consist of four specimens, two to be tested at 7 days and two at 28 days. [A set of test specimens for concrete with a 90-day strength per the same paragraph shall consist of six specimens, two tested at 7 days, two at 28 days, and two at 90 days.] Test specimens shall be molded and cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39 for test cylinders and ASTM C 78 for test beams. Results of all strength tests shall be reported immediately to the Contracting Officer. Quality control charts shall be kept for individual strength "tests", ("test" as defined in paragraph Strength Requirements in PART 1) moving average of last 3 "tests" for strength, and moving average for range for the last 3 "tests" for each mixture. The charts shall be similar to those found in ACI 214.3R.

3.17.6 Inspection Before Placing

Foundations, construction joints, forms, and embedded items shall be inspected by the Contractor in sufficient time prior to each concrete placement in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

3.17.7 Placing

The placing foreman shall supervise placing operations, shall determine that the correct quality of concrete or grout is placed in each location as specified and as directed by the Contracting Officer, and shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume placed, and method of placement. The placing foreman shall not permit batching and placing to begin until it has been verified that an adequate number of vibrators in working order and with competent operators are available. Placing shall not be continued if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

3.17.8 Vibrators

The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made as directed when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head, and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing. Any vibrator not meeting the requirements of paragraph Consolidation, shall be immediately removed from service and repaired or replaced.

3.17.9 Curing Inspection

a. Moist Curing Inspections. At least once each shift, and not less than twice per day on both work and non-work days, an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.

b. Moist Curing Corrective Action. When a daily inspection report lists an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for those areas shall be extended by 1 day.

c. Membrane Curing Inspection. No curing compound shall be applied until the Contractor has verified that the compound is properly mixed and ready for spraying. At the end of each operation, the Contractor shall estimate the quantity of compound used by measurement of the container and the area of concrete surface covered, shall compute the rate of coverage in square feet per gallon, and shall note whether or not coverage is uniform.

d. Membrane Curing Corrective Action. When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.

e. Sheet Curing Inspection. At least once each shift and once per day on non-work days, an inspection shall be made of all areas being cured using impervious sheets. The condition of the covering and the tightness of the laps and tapes shall be noted and recorded.

f. Sheet Curing Corrective Action. When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, the tears and holes shall promptly be repaired or the sheets replaced, the joints closed, and the required curing period for those areas shall be extended by 1 day.

3.17.10 Cold-Weather Protection

At least once each shift and once per day on non-work days, an inspection shall be made of all areas subject to cold-weather protection. Any deficiencies shall be noted, corrected, and reported.

3.17.11 Mixer Uniformity

a. Stationary Mixers. Prior to the start of concrete placing and once every 6 months when concrete is being placed, or once for every 75,000 cubic yards of concrete placed, whichever results in the shortest time interval, uniformity of concrete mixing shall be determined in accordance with ASTM C 94.

b. Truck Mixers. Prior to the start of concrete placing and at least once every 6 months when concrete is being placed, uniformity of concrete mixing shall be determined in accordance with ASTM C 94. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.

c. Mixer Uniformity Corrective Action. When a mixer fails to meet mixer uniformity requirements, either the mixing time shall be increased, batching sequence changed, batch size reduced, or adjustments shall be made to the mixer until compliance is achieved.

3.17.12 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

-- End of Section --

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SECTION 04200

MASONRY
07/92

****
NOTE: This guide specification covers the requirements for reinforced and nonreinforced masonry. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for CMU, brick, prefaced CMU, glass blocks, clay facing units, PC items, stone, and insulation. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.
****

PART 1 GENERAL

****
NOTE: This guide specification covers reinforced

and nonreinforced masonry and must be tailored to reflect the type of construction used in the design.

In general, reinforced masonry is defined as masonry construction which contains vertical bar reinforcement, horizontal bar or joint reinforcement, mortar, and grout combined in a manner that the component materials will act together to resist the design loading conditions.

Masonry not meeting the above definition but bonded together with mortar and containing, if necessary, the minimum amount of reinforcement for crack control and vertical stiffeners, is classified as nonreinforced masonry.

The project drawings should show all necessary details, architectural and structural, including wall sections, masonry bond and pattern details, control joint locations and details, joint dimensions, reinforcement locations and details, anchor details, bond beam and special unit details, masonry dimensions, and other similar details to complement this section.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI SP-66	(1994) ACI Detailing Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 82	(1997a) Steel Wire, Plain, for Concrete Reinforcement
ASTM A 153/A 153M	(1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 615/A 615M	(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 55	(1997a) Concrete Brick

ASTM C 62	(1997a) Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 67	(1998a) Sampling and Testing Brick and Structural Clay Tile
ASTM C 90	(1998) Loadbearing Concrete Masonry Units
ASTM C 91	(1998) Masonry Cement
ASTM C 126	(1996) Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units
ASTM C 129	(1997) Nonloadbearing Concrete Masonry Units
ASTM C 140	(1998b) Sampling and Testing Concrete Masonry Units
ASTM C 216	(1998) Facing Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 270	(1997ae1) Mortar for Unit Masonry
ASTM C 476	(1998) Grout for Masonry
ASTM C 494	(1998) Chemical Admixtures for Concrete
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 641	(1982; R 1991) Staining Materials in Lightweight Concrete Aggregates
ASTM C 652	(1997) Hollow Brick (Hollow Masonry Units Made From Clay or Shale)
ASTM C 744	(1998) Prefaced Concrete and Calcium Silicate Masonry Units
ASTM C 780	(1996) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C 1019	(1989a; R 1998) Sampling and Testing Grout
ASTM C 1072	(1998) Measurement of Masonry Flexural Bond Strength
ASTM C 1289	(1998) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D 2000	(1998c) Rubber Products in Automotive Applications
ASTM D 2240	(1997el) Rubber Property - Durometer Hardness

ASTM D 2287	(1996) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E 119	(1998) Fire Tests of Building Construction and Materials
ASTM E 447	(1992b) Compressive Strength of Masonry Prisms

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Clay or Shale Brick; GA. Concrete Brick; GA. Prefaced Concrete Masonry Units; GA. Glass Block Units and Accessories; GA. Insulation; GA. Ceramic Glazed Structural Clay Facing Units; GA.

Manufacturer's descriptive data.

SD-04 Drawings

Masonry Work; GA.

Drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; control and expansion joints; and wall openings. Bar splice locations shall be shown. Drawings shall be provided showing the location and layout of glass block units. Bent bars shall be identified on a bending diagram and shall be referenced and located on the drawings. Wall dimensions, bar clearances, and wall openings greater than one masonry unit in area shall be shown. No approval will be given to the shop drawings until the Contractor certifies that all openings, including those for mechanical and electrical service, are shown. If, during construction, additional masonry openings are required, the approved shop drawings shall be resubmitted with the additional openings shown along with the proposed changes. Location of these additional openings shall be clearly highlighted. The minimum scale for wall elevations shall be 1/4 inch per foot. Reinforcement bending details shall conform to the requirements of ACI SP-66.

SD-08 Statements

Cold Weather Installation; GA.

Cold weather construction procedures.

SD-09 Reports

Efflorescence Test; GA. Field Testing of Mortar; GA. Field Testing of Grout; GA. Prism tests; GA. Masonry Cement; GA. Fire-rated CMU; GA.

Test reports from an approved independent laboratory. Test reports on a previously tested material shall be certified as the same as that proposed for use in this project.

Special Inspection; GA.

Copies of masonry inspector reports.

SD-13 Certificates

Clay or Shale Brick; FI0. Concrete Brick; FIO. Concrete Masonry Units (CMU); FIO. Prefaced Concrete Masonry Units; FIO. Control Joint Keys; FIO. Anchors, Ties, and Bar Positioners; FIO. Expansion-Joint Materials; FIO. Joint Reinforcement; FIO. Reinforcing Steel Bars and Rods; FIO. Masonry Cement; FIO. Mortar Coloring; FIO. Insulation; FIO. Precast Concrete Items; FIO. Mortar Admixtures; FIO. Grout Admixtures; FIO. Glass Block Units and Accessories; FIO. Ceramic Glazed Structural Clay Facing Units; FIO.

Certificates of compliance stating that the materials meet the specified requirements.

Insulation; [_____].

Certificate attesting that the polyurethane or polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

SD-14 Samples

Concrete Masonry Units (CMU); GA. Prefaced Concrete Masonry Units; GA. Concrete Brick; GA. Stone Items; GA. Glass Block Units and Accessories; GA. Clay or Shale Brick; GA. Ceramic Glazed Structural Clay Facing Units; GA.

Color samples of three stretcher units and one unit for each type of special shape. Units shall show the full range of color and texture.

Anchors, Ties, and Bar Positioners; GA.

Two of each type used.

Expansion-Joint Material; GA.

One piece of each type used.

Joint Reinforcement; GA.

One piece of each type used, including corner and wall intersection pieces, showing at least two cross wires.

Insulation; GA.

One piece of board type insulation, not less than 16 inchesby 24 inches in size, containing the label indicating the rated permeance and R-values.

Portable Panel; GA.

One panel of clay or shale brick, 2 feet by 2 feet, containing approximately 24 brick facings to establish range of color and texture.

1.3 SAMPLE MASONRY PANELS

****

NOTE: Sample panels will be required for structures having over 185 square meters (2,000 square feet) of exterior wall area, including openings, and for smaller structures where appearance is important. Sample panels may be deleted for prefaced concrete masonry units where the use of these materials is limited, such as wainscots in toilet rooms. The list of items to be shown by the sample panel will be edited to provide only the representative items. Typical installation of electrical conduit and boxes may be illustrated by the sample panel when deemed appropriate.

****

After material samples are approved and prior to starting masonry work, sample masonry panels shall be constructed for each type and color of masonry required. At least 48 hours prior to constructing the sample panel or panels, the Contractor shall submit written notification to the Contracting Officer's Representative. Sample panels shall not be built in, or as part of the structure, but shall be located where directed.

1.3.1 Configuration

Panels shall be L-shaped or otherwise configured to represent all of the wall elements. Panels shall be of the size necessary to demonstrate the acceptable level of workmanship for each type of masonry represented on the project. The minimum size of a straight panel or a leg of an L-shaped panel shall be 8 feet long by [4] [6] feet high.

1.3.2 Composition

Panels shall show full color range, texture, and bond pattern of the masonry work. The Contractor's method for mortar joint tooling; grouting of reinforced vertical cores, collar joints, bond beams, and lintels; positioning, securing, and lapping of reinforcing steel; positioning and lapping of joint reinforcement (including prefabricated corners); and cleaning of masonry work shall be demonstrated during the construction of the panels. Installation or application procedures for anchors, wall ties, glass block units, CMU control joints, brick expansion joints, insulation, flashing, brick soldier, row lock courses and weep holes shall be shown in the sample panels. The panels shall contain [a masonry bonded corner] [a stacked bond corner] that includes a bond beam corner. Panels shall show [parging] [and] [installation of electrical boxes and conduit]. Panels that represent reinforced masonry shall contain a 2 foot by 2 foot opening placed at least 2 feet above the panel base and 2 feet away from all free edges, corners, and control joints. Required reinforcing shall be provided around this opening as well as at wall corners and control joints.

1.3.3 Construction Method

Where anchored veneer walls are required, the Contractor shall demonstrate and receive approval for the method of construction; i.e., either bring up the two wythes together or separately, with the insulation and appropriate ties placed within the specified tolerances across the cavity. Temporary provisions shall be demonstrated to preclude mortar or grout droppings in the cavity and to provide a clear open air space of the dimensions shown on the drawings. Where masonry is to be grouted, the Contractor shall demonstrate and receive approval on the method that will be used to bring up the masonry wythes; support the reinforcing bars; and grout cells, bond beams, lintels, and collar joints using the requirements specified herein. If sealer is specified to be applied to the masonry units, sealer shall be applied to the sample panels. Panels shall be built on a properly designed concrete foundation.

1.3.4 Usage

The completed panels shall be used as the standard of workmanship for the type of masonry represented. Masonry work shall not commence until the sample panel for that type of masonry construction has been completed and approved. Panels shall be protected from the weather and construction operations until the masonry work has been completed and approved. After completion of the work, the sample panels, including all foundation concrete, shall become the property of the Contractor and shall be removed from the construction site.

1.4 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered, handled, stored, and protected to avoid chipping, breakage, and contact with soil or contaminating material.

1.4.1 Masonry Units

Concrete masonry units shall be covered or protected from inclement weather and shall conform to the moisture content as specified in ASTM C 90when delivered to the jobsite. In addition, glass block units and prefaced concrete units shall be stored with their finish surfaces covered. Prefabricated lintels shall be marked on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.4.2 Reinforcement, Anchors, and Ties

Steel reinforcing bars, coated anchors, ties, and joint reinforcement shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

1.4.3 Cementitious Materials, Sand and Aggregates

Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with manufacturers' names and brands. Cementitious material shall be stored in dry, weathertight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Sand and aggregates shall be stored in a manner to prevent contamination or segregation.

1.5   SPECIAL INSPECTION

****
NOTE: This paragraph will be used for masonry construction only when f'm used in design is more than 10 MPa (1500 psi).
****

A qualified masonry inspector approved by the Contracting Officer shall perform inspection of the masonry work. Minimum qualifications for the masonry inspector shall be 5 years of reinforced masonry inspection experience or acceptance by a State, municipality, or other governmental body having a program of examining and certifying inspectors for reinforced masonry construction. The masonry inspector shall be present during preparation of masonry prisms, sampling and placing of masonry units, placement of reinforcement (including placement of dowels in footings and foundation walls), inspection of grout space, immediately prior to closing of cleanouts, and during grouting operations. The masonry inspector shall assure Contractor compliance with the drawings and specifications. The masonry inspector shall keep a complete record of all inspections and shall submit daily written reports to the Quality Control Supervisory Representative reporting the quality of masonry construction.

PART 2   PRODUCTS

2.1   GENERAL REQUIREMENTS

The source of materials which will affect the appearance of the finished work shall not be changed after the work has started except with Contracting Officer's approval.

2.2   CLAY OR SHALE BRICK

****
NOTE: The manufacturer's name and color number or color range will be indicated on the drawings along with the following note: "Colors or color ranges indicated are for identification purposes only and are not intended to limit selection of similar color or color range from other manufacturers."

Grade SW brick provides a high degree of resistance to frost action and deterioration by weathering. Grade MW brick provides a moderate degree of resistance. Brick facings may be limited to Grade SW units where previous experience indicates that surfaces of Grade MW facings, 10 years of age in the project area, have deteriorated due to weathering.

Types FBS and HBS brick are for general use where normal size variation and color range is acceptable. Types FBX and HBX permit less variation. Types FBA

and HBA permit large variations for special architectural effect.

Bricks of various modular sizes are available and, if for architectural reasons, other size bricks are included in the design, the nominal size selected shall be specified as necessary.
****

Color range and texture of clay or shale brick shall be as indicated and shall conform to the approved sample. Grade SW shall be used for brick in contact with earth or grade and for [the first six exterior courses above grade] [all exterior work]. Grade SW or MW shall be used in other brickwork. Brick shall be tested for efflorescence. Clay or shale brick units shall be delivered factory-blended to provide a uniform appearance and color range in the completed wall.

2.2.1 Solid Clay or Shale Brick

****
NOTE: ASTM C 216 may be deleted for projects located where brick conforming to ASTM C 62 provides aesthetic appearance that does not detract from the design, is generally available and predominantly used in the area, and the specific brick will blend with existing or adjacent architecture.
****

Solid clay or shale brick shall conform to [ASTM C 62] [ASTM C 216, Type [FBS] [FBA] [FBX]]. Brick size shall be modular and the nominal size of the brick used shall be [_____] inchesthick, [_____] inches wide, and [_____] inches long. Minimum compressive strength of the brick shall be [_____] psi.

2.2.2 Hollow Clay or Shale Brick

Hollow clay or shale brick shall conform to ASTM C 652, Type [HBS] [HBX] [HBA] [HBB]. Brick size shall be modular and the nominal size of the brick used shall be [_____] inchesthick, [_____] inches wide, and [_____] inches long. Where vertical reinforcement is shown in hollow brick, the minimum cell dimension shall be 2-1/2 inches and the units shall be designed to provide precise vertical alignment of the cells. Minimum compressive strength of the brick shall be [_____] psi.

2.3 CONCRETE BRICK

****
NOTE: Type I units are moisture controlled units and will be specified to minimize shrinkage and cracking. Grade N is used for high strength and resistance to moisture penetration. Grade S is used for lesser strength and moisture resistance. Combined Grade-Type designations such as N-I and S-II are commonly used. Grade N-I units are for general use and may be exposed to weather. Split face brick (solid concrete facing units), where required by design, should be added to this

paragraph. A particular color and texture may be specified when locally available and competitively priced. Sizes may be specified for brick or split face brick where required by the design.
****

Concrete brick shall conform to ASTM C 55, Type I, Grade [N-I] [N] [S] [S-II]. Concrete brick may be used where necessary for filling out in concrete masonry unit construction.

2.4 CONCRETE MASONRY UNITS (CMU)

****
NOTE: Low alkali cement should be specified for use in CMU if efflorescence caused by the use of available cement is a problem. If efflorescence is not a problem edit last sentence.

A lightweight high performance CMU has been developed by USACERL. This unit provides equivalent performance to a standard normal weight CMU, yet weighs only 19 pounds. This CMU does not meet a strict interpretation of the ASTM C 90 requirements and may require a variance from local building officials. Contact USACERL for supporting technical information.
****

Hollow and solid concrete masonry units shall conform to ASTM C 90, Type I. Cement shall have a low alkali content and be of one brand.

2.4.1 Aggregates

****
NOTE: Where sufficient evidence based on previous construction experience indicates concrete masonry units manufactured from aggregate from a specific source may be subject to excessive popouts and/or staining, contract specifications may be written to exclude such aggregate.
****

Lightweight aggregates and blends of lightweight and heavier aggregates in proportions used in producing the units, shall comply with the following requirements when tested for stain-producing iron compounds in accordance with ASTM C 641: by visual classification method, the iron stain deposited on the filter paper shall not exceed the "light stain" classification.

2.4.2 Kinds and Shapes

****
NOTE: Bullnose units will be specified only in cases where sharp corners are considered objectionable, such as in heavy traffic areas. If bullnose units are specified, the locations of use will be detailed on the drawings and/or listed in

this paragraph.
****

Units shall be modular in size and shall include closer, jamb, header, lintel, and bond beam units and special shapes and sizes to complete the work as indicated. In exposed interior masonry surfaces, units having a bullnose shall be used for vertical external corners except at door, window, and louver jambs. Radius of the bullnose shall be 1 inch. Units used in exposed masonry surfaces in any one building shall have a uniform fine to medium texture and a uniform color.

2.4.2.1 Architectural Units

****
NOTE: Where architectural units are used, local sources should be checked to determine available shapes, sizes, patterns, and colors. Desired unit pattern should be clearly shown on the drawings. Delete integral coloring if units will be painted or if natural color is satisfactory. CMU veneer wythes should be solid units to minimize trapping water which could lead to damage from freezing, mildew, and efflorescence.
****

Units shall have patterned face shell. Face shell pattern shall be [fluted] [vertical scored] [split ribbed] [_____]. Units shall be integrally colored during manufacture. Color shall be [_____]. Patterned face shell shall be properly aligned in the completed wall.

2.4.2.2 Patterned, Decorative Screen Units

****
NOTE: Manufacturer's catalogs will be consulted for patterned units locally available. Optional designs of patterned units will be shown as necessary for competitive bidding.

Concrete masonry units conforming to applicable requirements of ASTM C 129 are suitable for interior nonload-bearing screens, and may be specified where required.
****

Patterned, decorative screen units shall conform to the applicable requirements of [ASTM C 90] [ASTM C 129]. Units shall have uniform through-the-wall pattern, color, and texture.

2.4.3 Fire-Rated CMU

****
NOTE: The thickness of fire-rated walls as well as the required fire rating will be indicated on the drawings. Such walls will be shown as continuous from floor to deck above. Sections and details of these walls will clearly indicate the extent of such

walls. Solid grouted concrete and concrete brick masonry 150 mm (6 inches) or greater in thickness will be considered a 4-hour fire-rated wall regardless of aggregate type.

****

Concrete masonry units used in fire-rated construction shown on the drawings shall be of minimum equivalent thickness for the fire rating indicated and the corresponding type of aggregates indicated in TABLE I. Units containing more than one of the aggregates listed in TABLE I will be rated on the aggregate requiring the greater minimum equivalent thickness to produce the required fire rating.

TABLE I

FIRE-RATED CONCRETE MASONRY UNITS

See note (a) below

	Minimum equivalent thickness inches for fire rating of:		
Aggregate Type	4 hours	3 hours	2 hours
Pumice	4.7	4.0	3.0
Expanded slag	5.0	4.2	3.3
Expanded clay, shale, or slate	5.7	4.8	3.7
Limestone, scoria, cinders or unexpanded slag	5.9	5.0	4.0
Calcareous gravel	6.2	5.3	4.2
Siliceous gravel	6.7	5.7	4.5

(a) Minimum equivalent thickness shall equal net volume as determined in conformance with ASTM C 140 divided by the product of the actual length and height of the face shell of the unit in inches. Where walls are to receive plaster or be faced with brick, or otherwise form an assembly; the thickness of plaster or brick or other material in the assembly will be included in determining the equivalent thickness.

2.5   PREFACED CONCRETE MASONRY UNITS

****

NOTE: Bullnose units will be specified only in cases where sharp corners are considered objectionable, such as in heavy traffic areas. If bullnose units are specified, the locations of use will be detailed on the drawings and/or listed in this paragraph.

****

Prefaced concrete masonry units shall conform to ASTM C 744 using masonry units conforming to ASTM C 90, Type 1. The facing shall turn over the edges and ends of the unit at least 3/8 inch in the direction of the thickness of the unit to form a lip at least 1/16 inch thick. Variation in color and texture shall not exceed that of the approved samples. All shapes and sizes shall be provided for a complete installation. Bullnose units shall be used along sills and caps and at vertical external corners including door jambs, window jambs, and other such openings. Radius of the bullnose shall be 1 inch. Base units shall be coved to meet finished floor surfaces where ceramic tile floor occurs.

2.6 GLASS BLOCK UNITS AND ACCESSORIES

****

NOTE: The desired physical characteristics (Light transmittance, reflectivity, pattern, size, etc.) should be described. Drawings will clearly show the clearances required for deflection and expansion.

****

Glass block units shall be size, type, pattern, and style specified. Units shall be made of clear colorless glass. Pattern shall be clear with [75] [_____] percent light transmission allowance. Ventilators and accessories shall be the products manufactured by or as recommended by the glass block manufacturer.

2.6.1 Exterior Glass Block Units

Units shall be [_____] pattern, [with LX] [without] fibrous glass insert [_____] texture, and shall be [7-3/4] [_____] inches by [7-3/4] [_____] inches by [3-7/8] [_____] inches. Reflective glass block units shall have a highly reflective oxide surface coating of a [gray] [_____] color.

2.6.2 Interior Glass Block Units

Units shall be [_____] pattern and shall be [7-3/4 inches by 7-3/4 inches by 3-1/8 inches] [[_____] inches by [_____] inches by 3-7/8 inches.]

2.6.3 Fire Rated Glass Block Units

Walls and partitions indicated on the drawings to be fire rated and containing glass block units shall use approved units that have been fire tested in accordance with ASTM E 119 to the indicated rating.

2.6.4 Solid Glass Block Units

Units shall be 7-5/8 inches by 7-5/8 inches by 3 inches.

2.6.5 Horizontal Joint Reinforcement

Joint reinforcement shall be factory fabricated from steel wire, and shall conform to ASTM A 82. Wire shall be zinc coated after fabrication by the hot-dip process conforming to ASTM A 153/A 153M, Class B-2. Reinforcement shall consist of two or more parallel longitudinal wires not lighter than 9 gauge weld connected with cross wires not lighter than 14 gauge at not greater than 8 inches on center. At least one longitudinal wire for each face of glass block shall be provided. Out-to-out dimension of the longitudinal wires shall be 1-1/2 inches less than the actual width of the block. Joint reinforcement in flat sections not less than 8 feet long shall be provided, except that corner reinforcements and other special shapes may be shorter.

2.6.6 Strip Anchor

Perforated steel strip shall be not less than 20 gauge, minimum of 1-3/4 inches wide by 24 inches long and galvanized after fabrication.

2.6.7 Wire-Type Anchor

Steel wire shall be not less than 9 gauge of approved design suitable for use with the panel stiffener provided and galvanized after fabrication.

2.6.8 Expansion Strip

Dense fibrous glass batt or material shall be as recommended by the glass block manufacturer.

2.6.9 Packing (Backer Rods)

Polyethylene foam, neoprene, or filler shall be as recommended by the sealant manufacturer.

2.7 CERAMIC GLAZED STRUCTURAL CLAY FACING UNITS

****

NOTE: Normally prefaced concrete masonry units will be specified as a Contractor's option to ceramic glazed structural clay facing units. Structurally the units will be considered as equal. Generally, Type SS ceramic glazed structural clay facing units should be used for stacked bond and Type S otherwise.

****

Ceramic glazed structural clay facing units shall conform to ASTM C 126, Type I, Grade [SS] [S] glaze and color as indicated. In two-faced walls, Type II units may be used for the base course. Variations in color and texture shall not exceed that of the approved samples. All shapes and sizes shall be provided for a complete installation. Bullnose units shall be used along sills and caps and at vertical external corners including door jambs, window jambs, and other such openings. Base units shall be coved to meet finished floor surfaces where ceramic tile floor occurs. Backs of units exposed in unfinished rooms shall be smooth and free from glaze. Backs of units receiving plaster shall be scored, combed, or otherwise roughened. Surfaces receiving mortar shall be reasonably free from glaze and suitable for receiving mortar.

2.8 PRECAST CONCRETE ITEMS

Trim, lintels, copings, splashblocks and door sills shall be factory-made units from a plant regularly engaged in producing precast concrete units. Unless otherwise indicated, concrete shall be 4,000 psi minimum conforming to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE using 1/2 inch to No. 4 nominal-size coarse aggregate, and minimum reinforcement shall be the reinforcement required for handling of the units. Clearance of 3/4 inch shall be maintained between reinforcement and faces of units. Unless precast-concrete items have been subjected during manufacture to saturated-steam pressure of at least 120 pounds per square inch for at least 5 hours, the items, after casting, shall be either damp-cured for 24 hours or steam-cured and shall then be aged under cover for 28 days or longer. Cast-concrete members weighing over 80 pounds shall have built-in loops of galvanized wire or other approved provisions for lifting and anchoring. Units shall have beds and joints at right angles to the face, with sharp true arises and shall be cast with drip grooves on the underside where units overhang walls. Exposed-to-view surfaces shall be free of surface voids, spalls, cracks, and chipped or broken edges. Precast units exposed-to-view shall be of uniform appearance and color. Unless otherwise specified, units shall have a smooth dense finish. Prior to use, each item shall be wetted and inspected for crazing. Items showing evidence of dusting, spalling, crazing, or having surfaces treated with a protective coating will be rejected.

2.8.1 Lintels

Precast lintels, unless otherwise shown, shall be of a thickness equal to the wall and reinforced with two No. 4 bars for the full length. Top of lintels shall be labeled "TOP" or otherwise identified and each lintel shall be clearly marked to show location in the structure.

2.8.2 Sills and Copings

Sills and copings shall be cast with washes. Sills for windows having mullions shall be cast in sections with head joints at mullions and a 1/4 inch allowance for mortar joints. The ends of sills, except a 3/4 inch wide margin at exposed surfaces, shall be roughened for bond. Treads of door sills shall have rounded nosings.

2.8.3 Splash Blocks

Splash blocks shall be as detailed. Reinforcement shall be the manufacturer's standard.

2.9 STONE ITEMS

****

NOTE: The stone specified herein is for structures requiring a limited quantity of cut stone. Where previous experience indicates difficulty in obtaining precast concrete trim of the specified quality, stone may be specified as a Contractor's option.

****

Stone for trim, sills, lintels, and copings shall be limestone, sandstone, or granite, and shall be cut to the design shown. Sandstone shall be standard grade, buff, gray, or buff brown, with a smooth finish free from clay pits and tool marks. Granite shall be a good commercial grade building granite of medium or moderately coarse grain, and a light or medium gray or light pink color, with a smooth machine finish on washes, 4-cut finish on treads, and 6-cut or equivalent machine finish on other exposed surfaces. Limestone shall be standard buff limestone with a smooth machine finish free from tool marks. Lintels, except when supported by a steel member, shall be 4 inches or more thick from face to back edge and of the depth required to support the masonry over the opening. Stone shall have beds and joints at right angles to the face, with sharp, true arises. Copings and sills shall be provided with washes, and where overhanging the walls, shall have drips cut on the underside.

2.10 MORTAR

****

NOTE: Type S mortar provides good strength, workability, weather tightness, durability and corrosion protection, and will be used for most work. It is recommended by ASTM C 270 for exterior, at or below grade, applications. Type S mortar is recommended for glass block.

Type N mortar generally provides improved workability and weather tightness. It has lower strength, durability and corrosion protection. It is recommended by ASTM C 270 for exterior above grade and interior applications.

The proportions allowed by ASTM C 270 for cement-lime mortars can result in properties that are essentially of another mortar type. Mortars proportioned for high strength can lead to debonding between the mortar joint and the brick resulting in reduced wall flexural capacity and increased water penetration leading to efflorescence problems. Therefore the proportions for cement-lime Types S and N mortars will be as shown below.

Mortar coloring may be specified as required by architectural design.

Low alkali cement should be specified for use in mortar if efflorescence caused by the use of available cement is a problem.

****

Mortar shall be Type [S] [N] in accordance with the proportion specification of ASTM C 270 except Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate; Type N cement-lime mortar proportions shall be 1 part cement, 1 part lime and 6 parts aggregate; when masonry cement ASTM C 91 is used the maximum air content shall be limited to 12 percent and performance equal to cement-lime mortar shall be verified. Verification of masonry cement performance shall be based on ASTM C 780 and ASTM C 1072. Mortar for prefaced concrete masonry unit wainscots shall contain aggregates with 100 percent passing the No. 8 sieve and 95 percent passing the No. 16 sieve. Pointing mortar in showers and kitchens shall contain ammonium stearate, or aluminum tri-stearate, or calcium stearate in an amount equal to 3 percent by weight of cement used. Cement shall have a low alkali content and be of one brand. Aggregates shall be from one source.

2.10.1 Admixtures

****

NOTE: Admixtures may cause efflorescence and may adversely affect the strength of the mix or the protection of embedded steel items.

****

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494, Type C.

2.10.2 Coloring

Mortar coloring shall be added to the mortar used for exposed masonry surfaces to produce a uniform color matching [_____]. Mortar coloring shall not exceed 3 percent of the weight of cement for carbon black and ten percent of the weight of cement for all other pigments. Mortar coloring shall be chemically inert, of finely ground limeproof pigment, and furnished in accurately pre-measured and packaged units that can be added to a measured amount of cement.

2.11 GROUT

****

NOTE: Low alkali cement should be specified for use in grout if efflorescence caused by the use of available cement is a problem.

****

Grout shall conform to ASTM C 476. Cement used in grout shall have a low alkali content. Grout slump shall be between 8 and 10 inches. Grout shall be used subject to the limitations of Table III. Proportions shall not be changed and materials with different physical or chemical characteristics shall not be used in grout for the work unless additional evidence is furnished that the grout meets the specified requirements.

2.11.1 Admixtures

****

NOTE: Admixtures, including air entrainment, may cause efflorescence and may adversely affect the strength of the mix or the protection of embedded steel items.

****

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494, Type C.

2.11.2 Grout Barriers

Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

2.12 ANCHORS, TIES, AND BAR POSITIONERS

****

NOTE: By definition, ties are connections between masonry elements, anchors connect masonry to the structure, and fasteners are for attachments to masonry. The anchors and ties specified in this paragraph are primarily used to laterally tie

masonry veneer to backup elements. Anchors and ties not incorporated in the design will be deleted. If special anchors or ties are required by the design, they will be specified to meet the necessary requirements.
****

Anchors and ties shall be fabricated without drips or crimps and shall be zinc-coated in accordance with ASTM A 153/A 153M, Class B-2. Steel wire used for anchors and ties shall be fabricated from steel wire conforming to ASTM A 82. Anchors and ties shall be sized to provide a minimum of 5/8 inch mortar cover from either face.

2.12.1 Wire Mesh Ties

****
NOTE: Wire mesh ties will only be used to tie 100 mm (4 inch) thick concrete masonry unit partitions to other intersecting masonry partition walls.
****

Wire mesh for tying 4 inch thick concrete masonry unit partitions to other intersecting masonry partitions shall be 1/2 inch mesh of minimum 16 gauge steel wire. Minimum lengths shall be not less than 12 inches.

2.12.2 Wall Ties

****
NOTE: Wall ties will be specified to provide an option to the typically used continuous joint reinforcement to anchor the outer wythe to the inner wythe of anchored veneer construction. Vertical spacing will normally be 400 mm (16 inches) on center and horizontal spacing of the unit ties will normally be 600 mm (24 inches) on center.

Z-shaped ties should only be specified when bonding walls constructed with solid units (not less than 75 percent of the gross cross-sectional area being solid). Rectangular ties may be used with either solid or hollow units.

Adjustable wall ties may be used in areas of low seismic activity when the design wind speed is less than 160 km/hr (100 mph); designer must follow the guidance provided in TI 809-04 Seismic Design for Buildings for any seismic design. Adjustable wall ties are normally used when constructing one wythe independent of the other. The preferred method of construction, however, is to bring the wythes up together. Delete the sentences pertaining to adjustable ties when they are not permitted.
****

Wall ties shall be rectangular-shaped or Z-shaped fabricated of 3/16 inch diameter zinc-coated steel wire. Rectangular wall ties shall be no less than 4 inches wide. Wall ties may also be of a continuous type conforming to paragraph JOINT REINFORCEMENT. Adjustable type wall ties, if approved for use, shall consist of two essentially U-shaped elements fabricated of 3/16 inch diameter zinc-coated steel wire. Adjustable ties shall be of the double pintle to eye type and shall allow a maximum of 1/2 inch eccentricity between each element of the tie. Play between pintle and eye opening shall be not more than 1/16 inch. The pintle and eye elements shall be formed so that both can be in the same plane.

2.12.3 Dovetail Anchors

Dovetail anchors shall be of the flexible wire type, 3/16 inch diameter zinc-coated steel wire, triangular shaped, and attached to a 12 gauge or heavier steel dovetail section. These anchors shall be used for anchorage of veneer wythes or composite-wall facings extending over the face of concrete columns, beams, or walls. Cells within vertical planes of these anchors shall be filled solid with grout for full height of walls or partitions, or solid units may be used. Dovetail slots are specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

2.12.4 Adjustable Anchors

****

NOTE: Adjustable anchors will be used to anchor masonry to structural steel columns or beams. The fixed portion of the anchors (steel anchor rods) will be welded to the structural steel member. In instances where standard anchors are not available, such as when anchoring masonry to a steel beam that is offset from the masonry wall line, anchors will be detailed on the drawings.

****

Adjustable anchors shall be 3/16 inch diameter steel wire, triangular-shaped. Anchors attached to steel shall be 5/16 inch diameter steel bars placed to provide 1/16 inch play between flexible anchors and structural steel members. Spacers shall be welded to rods and columns. Equivalent welded-on steel anchor rods or shapes standard with the flexible-anchor manufacturer may be furnished when approved. Welds shall be cleaned and given one coat of zinc-rich touch up paint.

2.12.5 Bar Positioners

Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 9 gauge steel wire or equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell.

2.13 JOINT REINFORCEMENT

****

NOTE: Location of horizontal joint reinforcement should be shown on the drawings. Reinforcement will have one wire in each mortar bed. Truss-type joint reinforcement will not be used. Adjustable joint reinforcement assemblies may be used in certain types of construction where it is feasible to construct one wythe independent of the other. If

the type of design does not permit this type of construction, delete the sentences pertaining to adjustable joint reinforcement assemblies.
****

Joint reinforcement shall be factory fabricated from steel wire conforming to ASTM A 82, welded construction. Tack welding will not be acceptable in reinforcement used for wall ties. Wire shall have zinc coating conforming to ASTM A 153/A 153M, Class B-2. All wires shall be a minimum of [9] [_____] gauge. Reinforcement shall be ladder type design, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units. Joint reinforcement shall be placed a minimum of 5/8 inch cover from either face. The distance between crosswires shall not exceed 16 inches. Joint reinforcement for straight runs shall be furnished in flat sections not less than 10 feet long. Joint reinforcement shall be provided with factory formed corners and intersections. If approved for use, joint reinforcement may be furnished with adjustable wall tie features.

2.14 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A 615/A 615M, Grade 60.

2.15 CONTROL JOINT KEYS

****
NOTE: Control joint keys are generally not required vertically between the floor line or grade to other floor lines or roofs and no shear transfer is required across control joints. Delete paragraph when not required. Control joints will be detailed on the drawings. When control joint keys are not required by design, the control joint detail will show the head joint completely filled with mortar for the width of the wythe; but joints will be flush, raked, or raked and sealed as required.
****

Control joint keys shall be a factory fabricated solid section of natural or synthetic rubber (or combination thereof) conforming to ASTM D 2000or polyvinyl chloride conforming to ASTM D 2287. The material shall be resistant to oils and solvents. The control joint key shall be provided with a solid shear section not less than 5/8 inchthick and 3/8 inch thick flanges, with a tolerance of plus or minus 1/16 inch. The control joint key shall fit neatly, but without forcing, in masonry unit jamb sash grooves. The control joint key shall be flexible at a temperature of minus 30 degrees F after five hours exposure, and shall have a durometer hardness of not less than 70 when tested in accordance with ASTM D 2240.

2.16 EXPANSION-JOINT MATERIALS

Backer rod and sealant shall be adequate to accommodate joint compression equal to 50 percent of the width of the joint. The backer rod shall be compressible rod stock of polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, nonabsorptive material as recommended by the sealant manufacturer. Sealant shall conform to Section 07900JOINT SEALING.

2.17 INSULATION

2.17.1 Rigid Board-Type Insulation

****

NOTE: Insert the appropriate thickness and R-Value to be used for the insulation. The total R-value for the insulation and the total thickness of the insulation must be coordinated to fit the space provided within the wall cavity. The thickness of the insulation must allow for not less than 20 mm (3/4 inch) air space between the insulation and the facing veneer. This will limit the insulation thickness to 50 mm (2 inches) in a 70 mm (2-3/4 inch) cavity space. If greater insulation thickness is required the masonry wall must be designed to provide a larger cavity.

To assure adequate competition, an R-value should be chosen that allows several products to meet the specified thickness. The range of design R-values (in IP units) for foam insulations given by ASHRAE is 5 to 7 per inch. Verify range available from manufacturers. An aged R-value in SI units of 2 (11, in IP units) can be readily achieved with 50 mm (2 inches) of insulation.

Cellular plastic insulations (polystyrene, polyurethane and polyisocyanurate) are thermally efficient, however, certain precautions should be observed in their use due to high smoke development and toxicity of the smoke generated by the burning of these materials. Cellular plastic insulations should only be used in anchored veneer masonry walls where the insulation is completely isolated from the interior of the building by masonry, including all penetrations of the interior wythe.

****

Rigid board-type insulation shall be extruded polystyrene, polyurethane, or polyisocyanurate. Polystyrene shall conform to ASTM C 578. Polyurethane or polyisocyanurate shall conform to ASTM C 1289, Type I, Class 2, faced with aluminum foil on both sides of the foam. The insulation shall be a standard product and shall be marked with not less than the manufacturer's trademark or name, the specification number, the permeance and R-values.

2.17.1.1 Insulation Thickness and Air Space

The cavity space shall allow for a maximum insulation thickness of [2] [_____] inches, and a minimum air space of 3/4 inch.

2.17.1.2 Aged R-Value

The insulation shall provide a minimum aged R-value of [11] [_____] for the overall thickness. The aged R-value shall be determined at 75 degrees

F in accordance with the appropriate referenced specification. The stated R-value of the insulation shall be certified by an independent testing laboratory or certified by an independent Registered Professional Engineer if tests are conducted in the manufacturer's laboratory.

2.17.1.3 Recovered Material

Insulation shall contain the highest practicable percentage of recovered material derived from solid waste (but material reused in the manufacturing process cannot be counted toward the percentage of recovered material). Where two materials have the same price and performance, the one containing the higher recovered material content shall be provided. The polyurethane or polyisocyanurate foam shall have a minimum recovered material content of 9 percent by weight of the core material.

2.17.2 Insulation Adhesive

Insulation adhesive shall be specifically prepared to adhere the insulation to the masonry and, where applicable, to the thru-wall flashing. The adhesive shall not deleteriously affect the insulation, and shall have a record of satisfactory and proven performance for the conditions under which to be used.

2.18 FLASHING

Flashing shall be as specified in Section 07600 SHEET METALWORK, GENERAL.

2.19 WEEP HOLE VENTILATORS

Weephole ventilators shall be prefabricated aluminum grill type vents designed to prevent insect entry with maximum air entry. Ventilators shall be sized to match modular construction with a standard 3/8 inch mortar joint.

PART 3 EXECUTION

3.1 ENVIRONMENTAL REQUIREMENTS

3.1.1 Hot Weather Installation

The following precautions shall be taken if masonry is erected when the ambient air temperature is more than 99 degrees F in the shade and the relative humidity is less than 50 percent. All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than 4 feet ahead of masonry; masonry units shall be set within one minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

3.1.2 Cold Weather Installation

Before erecting masonry when ambient temperature or mean daily air temperature falls below 40 degrees F, a written statement of proposed cold weather construction procedures shall be submitted for approval. The following precautions shall be taken during all cold weather erection.

3.1.2.1 Preparation

Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

a. Air Temperature 40 to 32 Degrees F. Sand or mixing water shall be heated to produce mortar temperatures between 40 degrees F and 120 degrees F.

b. Air Temperature 32 to 25 Degrees F.Sand and mixing water shall be heated to produce mortar temperatures between 40 degrees F and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing.

c. Air Temperature 25 to 20 Degrees F. Sand and mixing water shall be heated to provide mortar temperatures between 40 degrees F and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is in excess of 15 mph.

d. Air Temperature 20 Degrees F and below. Sand and mixing water shall be heated to provide mortar temperatures between 40 degrees F and 120 degrees F. Enclosure and auxiliary heat shall be provided to maintain air temperature above 32 degrees F. Temperature of units when laid shall not be less than 20 degrees F.

3.1.2.2 Completed Masonry and Masonry Not Being Worked On

a. Mean daily air temperature 40 degrees F to 32 degrees F. Masonry shall be protected from rain or snow for 24 hours by covering with weather-resistive membrane.

b. Mean daily air temperature 32 degrees F to 25 degrees F. Masonry shall be completely covered with weather-resistant membrane for 24 hours.

c. Mean Daily Air Temperature 25 Degrees F to 20 Degrees F. Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.

d. Mean Daily Temperature 20 Degrees F and Below. Masonry temperature shall be maintained above 32 degrees F for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

3.1.2.3 Glass Block Requirements

Glass block shall not be laid when the air temperature is below 40 degrees F on a falling thermometer, or when it appears probable that temperatures below 40 degrees F will be encountered before the mortar has set, unless adequate means are provided for protecting the work from freezing. Protection shall consist of heating and maintaining the temperature of the glass block and mortar materials at not less than 40 degrees F and not more than 160 degrees F. After erection, an air temperature above 40 degrees F on both sides of the glass block shall be maintained for not less than 72 hours. Work will not be permitted with or on frozen materials. Glass block work may be started at 34 degrees F on a rising thermometer.

3.2 LAYING MASONRY UNITS

Masonry units shall be laid in [running] [stacked] [the indicated] bond pattern. Facing courses shall be level with back-up courses, unless the use of adjustable ties has been approved in which case the tolerances shall be plus or minus 1/2 inch. Each unit shall be adjusted to its final position while mortar is still soft and plastic. Units that have been disturbed after the mortar has stiffened shall be removed, cleaned, and relaid with fresh mortar. Air spaces, cavities, chases, expansion joints, and spaces to be grouted shall be kept free from mortar and other debris. Units used in exposed masonry surfaces shall be selected from those having the least amount of chipped edges or other imperfections detracting from the appearance of the finished work. Vertical joints shall be kept plumb. Units being laid and surfaces to receive units shall be free of water film and frost. Solid units shall be laid in a nonfurrowed full bed of mortar. Mortar for veneer wythes shall be beveled and sloped toward the center of the wythe from the cavity side. Units shall be shoved into place so that the vertical joints are tight. Vertical joints of brick and the vertical face shells of concrete masonry units, except where indicated at control, expansion, and isolation joints, shall be completely filled with mortar. Mortar will be permitted to protrude up to 1/2 inch into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below. In double wythe construction, the inner wythe may be brought up not more than 16 inches ahead of the outer wythe. Collar joints shall be filled with mortar or grout during the laying of the facing wythe, and filling shall not lag the laying of the facing wythe by more than 8 inches.

3.2.1 Surface Preparation

Surfaces upon which masonry is placed shall be cleaned of laitance, dust, dirt, oil, organic matter, or other foreign materials and shall be slightly roughened to provide a surface texture with a depth of at least 1/8 inch. Sandblasting shall be used, if necessary, to remove laitance from pores and to expose the aggregate.

3.2.2 Forms and Shores

Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed in less than 10 days.

3.2.3 Concrete Masonry Units

Units in piers, pilasters, columns, starting courses on footings, solid foundation walls, lintels, and beams, and where cells are to be filled with grout shall be full bedded in mortar under both face shells and webs. Other units shall be full bedded under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Foundation walls below grade shall be grouted solid. Jamb units shall be of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, gable slopes, and elsewhere as approved. Double walls shall be stiffened at wall-mounted plumbing fixtures by use of strap anchors, two above each fixture and two below each fixture, located to avoid pipe runs, and extending from center to center of the double wall. Walls and partitions shall be adequately reinforced for support of wall-hung plumbing fixtures when chair carriers are not specified.

3.2.4   Clay or Shale Brick Units

Brick facing shall be laid with the better face exposed. Brick shall be laid in running bond with each course bonded at corners, unless otherwise indicated. Molded brick shall be laid with the frog side down. Brick that is cored, recessed, or has other deformations may be used in sills, treads, soldier courses, except where deformations will be exposed to view.

3.2.4.1   Wetting of Units

****

NOTE: If clay, shale brick, or hollow brick is specified, include wetting requirements for units having an initial rate of absorption of more than 0.155 gm per minute per square cm (1 gm per minute per square inch) (one gram per minute per square inch) of bed surface.

****

Wetting of clay, shale brick, or hollow brick units having an initial rate of absorption of more than 1 gram per minute per square inch of bed surface shall be in conformance with ASTM C 67. The method of wetting shall ensure that each unit is nearly saturated but surface dry when laid.

3.2.4.2   Solid Units

Bed, head, and collar joints shall be completely filled with mortar.

3.2.4.3   Hollow Units

Hollow units shall be laid as specified for concrete masonry units.

3.2.5   Tolerances

Masonry shall be laid plumb, true to line, with courses level. Bond pattern shall be kept plumb throughout. Corners shall be square unless noted otherwise. Except for walls constructed of prefaced concrete masonry units, masonry shall be laid within the following tolerances (plus or minus unless otherwise noted):

TABLE II

TOLERANCES

Variation from the plumb in the lines and surfaces of columns, walls and arises	
In adjacent masonry units	1/8 inch
In 10 feet	1/4 inch
In 20 feet	3/8 inch
In 40 feet or more	1/2 inch

Variations from the plumb for external corners, expansion joints, and other conspicuous lines	
In 20 feet	1/4 inch

TOLERANCES	
In 40 feet or more	1/2 inch
Variations from the level for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines	
In 20 feet	1/4 inch
In 40 feet or more	1/2 inch
Variation from level for bed joints and top surfaces of bearing walls	
In 10 feet	1/4 inch
In 40 feet or more	1/2 inch
Variations from horizontal lines	
In 10 feet	1/4 inch
In 20 feet	3/8 inch
In 40 feet or more	1/2 inch
Variations in cross sectional dimensions of columns and in thickness of walls	
Minus	1/4 inch
Plus	1/2 inch

3.2.6 Cutting and Fitting

Full units of the proper size shall be used wherever possible, in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp. Openings in the masonry shall be made carefully so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Reinforced masonry lintels shall be provided above openings over 12 inches wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

3.2.7 Jointing

Joints shall be tooled when the mortar is thumbprint hard. Horizontal joints shall be tooled last. Joints shall be brushed to remove all loose and excess mortar. Mortar joints shall be finished as follows:

3.2.7.1 Flush Joints

Joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas shall be flush cut. Flush cut joints shall be made by cutting off the mortar flush with the face of the wall. Joints in unparged masonry walls below grade shall be pointed tight. Flush joints for architectural units, such as fluted units, shall completely fill both the head and bed joints.

3.2.7.2 Tooled Joints

****
NOTE: Joints in exterior masonry walls exposed to weather will be tooled with an approved mortar joint, typically a slightly concave joint. Other joints that are suitable for weathertight construction and may be considered for architectural purposes are: Vee, Beaded, or Weathered types. Exposed to view or painted interior masonry walls will also be tooled, typically with a slightly concaved joint, but may also be tooled with other joint types as architecturally desired.
****

Joints in exposed exterior and interior masonry surfaces shall be tooled [slightly concave] [_____]. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Tooling shall be performed so that the mortar is compressed and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

3.2.7.3 Door and Window Frame Joints

On the exposed interior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch.

3.2.8 Joint Widths

Joint widths shall be as follows:

3.2.8.1 Concrete Masonry Units

Concrete masonry units shall have 3/8 inch joints, except for prefaced concrete masonry units.

3.2.8.2 Prefaced Concrete Masonry Units

Prefaced concrete masonry units shall have a joint width of 3/8 inch wide on unfaced side and not less than 3/16 inch nor more than 1/4 inch wide on prefaced side.

3.2.8.3 Brick

Brick joint widths shall be the difference between the actual and nominal dimensions of the brick in either height or length. Brick expansion joint widths shall be as shown.

3.2.9 Embedded Items

Spaces around built-in items shall be filled with mortar. Openings around flush-mount electrical outlet boxes in wet locations shall be pointed with mortar. Anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in shall be embedded as the masonry work progresses. Anchors, ties and joint reinforcement shall be fully embedded in the mortar. Cells receiving anchor bolts and cells of the first course below bearing plates shall be filled with grout.

3.2.10 Unfinished Work

Unfinished work shall be stepped back for joining with new work. Toothing may be resorted to only when specifically approved. Loose mortar shall be removed and the exposed joints shall be thoroughly cleaned before laying new work.

3.2.11 Masonry Wall Intersections

****
NOTE: Details will be shown on the drawings which illustrate corners and intersections of structural bond beam reinforcement and factory-formed joint reinforcement. When joint reinforcement is not used, delete prefabricated corners or tee pieces.
****

Each course shall be masonry bonded at corners and elsewhere as shown. Masonry walls shall be anchored or tied together at corners and intersections with bond beam reinforcement and prefabricated corner or tee pieces of joint reinforcement as shown.

3.2.12 Partitions

****
NOTE: Walls and partitions which serve as fire walls or fire-rated walls will be shown. Sections and details of these walls will clearly indicate the extent of such walls. Non-structural masonry partition walls will not be tied in any way to structural or exterior masonry walls. Isolation joints will be used at these intersections. When 100 mm (4 inch) masonry partitions are not used, delete reference to these units and their intersections.
****

Partitions shall be continuous from floor to underside of floor or roof deck where shown. Openings in firewalls around joists or other structural members shall be filled as indicated or approved. Where suspended ceilings on both sides of partitions are indicated, the partitions other than those shown to be continuous may be stopped approximately 4 inches above the ceiling level. An isolation joint shall be placed in the intersection between partitions and structural or exterior walls as shown. Interior partitions having 4 inch nominal thick units shall be tied to intersecting partitions of 4 inch units, 5 inches into partitions of 6 inch units, and 7 inches into partitions of 8 inch or thicker units. Cells within vertical plane of ties shall be filled solid with grout for full height of partition or solid masonry units may be used. Interior partitions having masonry walls over 4 inches thick shall be tied together with joint reinforcement. Partitions containing joint reinforcement shall be provided with prefabricated pieces at corners and intersections or partitions.

3.3 ANCHORED VENEER CONSTRUCTION

****

NOTE: Adjustable joint reinforcement assemblies may be used at locations of low seismic activity where the design wind speed is less than 160 km/hour (100 mph); designer must follow the guidance provided in TI 809-04 Seismic Design for Buildings for any seismic design. Adjustable assemblies are normally used when constructing one wythe independent of the other. If the design does not permit this type of construction, delete the reference pertaining to adjustable joint reinforcement assemblies. The preferred method of construction, however, is to bring the wythes up together. Typically, continuous joint reinforcement is used to tie the two wythes together as well as providing for shrinkage cracking control. Continuous joint reinforcement, used as wall ties, will typically be spaced not over 400 mm (16 inches) on center vertically. Spacing of joint reinforcement will be shown on the contract drawings.

****

The inner and outer wythes shall be completely separated by a continuous airspace as shown on the drawings. Both the inner and the outer wythes shall be laid up together except when adjustable joint reinforcement assemblies are approved for use. When both wythes are not brought up together, through-wall flashings shall be protected from damage until they are fully enclosed in the wall. The airspace between the wythes shall be kept clear and free of mortar droppings by temporary wood strips laid on the wall ties and carefully lifted out before placing the next row of ties. A coarse gravel or drainage material shall be placed behind the weep holes in the cavity to a minimum depth of 4 inches of coarse aggregate or 10 inches of drainage material to keep mortar droppings from plugging the weep holes.

3.4 WEEP HOLES

Weep holes shall be provided not more than 24 inches on centers in mortar joints of the exterior wythe above wall flashing, over foundations, bond beams, and any other horizontal interruptions of the cavity. [Weep holes shall be formed by placing short lengths of well-greased No. 10, 5/16 inch nominal diameter, braided cotton sash cord in the mortar and withdrawing the cords after the wall has been completed.] [Weep holes shall be constructed using weep hole ventilators.] Other approved methods may be used for providing weep holes. Weep holes shall be kept free of mortar and other obstructions.

3.5 COMPOSITE WALLS

Masonry wythes shall be tied together with joint reinforcement or with unit wall ties. Facing shall be anchored to concrete backing with wire dovetail anchors set in slots built in the face of the concrete as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. The facing wythe shall be anchored or tied to the backup at a maximum spacing of 16 inches on center vertically and 24 inches on center horizontally. Unit ties shall be spaced not over 24 inches on centers horizontally, in courses not over 16 inches apart vertically, staggered in alternate courses. Ties shall be laid not closer than 5/8 inch to either masonry face. Ties shall not extend through control joints. Collar joints between masonry facing and masonry backup shall be filled solidly with grout.

3.6 PREFACED CONCRETE MASONRY UNITS

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Note: Designer should show reinforcing details for two-faced walls.

****

Prefaced concrete masonry units shall be installed as specified for concrete masonry units and as required herein. Single-faced units may be installed through the wall where walls or partitions are indicated to have structural clay facing unit finish on one side only. The facing shall be used for dimensional and plane reference in the installation. Two-faced walls or partitions shall consist of two units bonded and tied together as specified for composite walls. Wainscots shall be of full courses to approximate as nearly as possible the height indicated, except that in no case shall the wainscots be lower than 2 inches below the specified height. Units shall be set level and true so that bases and walls will present true planes and surfaces free of waviness, offset, or other distortion. Joint reinforcing shall be placed not over 16 inches on center vertically.

3.7 GLASS BLOCK

Glass block shall be installed as recommended by the glass block manufacturer and as specified in paragraph ENVIRONMENTAL REQUIREMENTS, after coordinating the work with other trades to accommodate embedded items.

3.8 CERAMIC GLAZED STRUCTURAL CLAY FACING UNITS

****

NOTE: Details on drawings should include two faced walls built-up from two units, except for the base. Two-faced glazed units will normally not be used because of the difficulties in maintaining the faces of the units in the same plane.

****

Ceramic glazed structural clay facing units shall be at set level and true so that bases and wall surfaces will present true planes with finished surfaces free of waviness, off-sets, or other distortions.

3.9 MORTAR

Mortar shall be mixed in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measurement of ingredients for mortar shall be by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Mortar that has stiffened because of loss of water through evaporation shall be retempered by adding water to restore the proper consistency and workability. Mortar that has reached its initial set or that has not been used within [2-1/2] [_____] hours after mixing shall be discarded.

3.10   REINFORCING STEEL

Reinforcement shall be cleaned of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within 2 inches of tops of walls.

3.10.1   Positioning Bars

****

NOTE: Positioning of bars will be shown on the drawings.

****

Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 1/2 inchshall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one diameter of the reinforcement. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement. Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

3.10.2   Splices

Bars shall be lapped a minimum of 48 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

3.11   JOINT REINFORCEMENT

****

NOTE: Location of horizontal joint reinforcement should be shown on the drawings with the maximum vertical spacing normally being 400 mm (16 inches).

****

Joint reinforcement shall be installed at 16 inches on center or as indicated. Reinforcement shall be lapped not less than 6 inches. Prefabricated sections shall be installed at corners and wall intersections. The longitudinal wires of joint reinforcement shall be placed to provide not less than 5/8 inch cover to either face of the unit.

3.12   PLACING GROUT

Cells containing reinforcing bars shall be filled with grout. Hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces shall be filled solid with grout. Cells under lintel bearings on each side of openings shall be filled solid with grout for full height of openings. Walls below grade, lintels, and bond beams shall be filled solid with grout. Units other than open end units may require grouting each course to preclude voids in the units. Grout not in place within 1-1/2 hours after water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of face shells of masonry units. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt.

3.12.1 Vertical Grout Barriers for Fully Grouted Walls

Grout barriers shall be provided not more than 30 feet apart, or as required, to limit the horizontal flow of grout for each pour.

3.12.2 Horizontal Grout Barriers

Grout barriers shall be embedded in mortar below cells of hollow units receiving grout.

3.12.3 Grout Holes and Cleanouts

3.12.3.1 Grout Holes

Grouting holes shall be provided in slabs, spandrel beams, and other in-place overhead construction. Holes shall be located over vertical reinforcing bars or as required to facilitate grout fill in bond beams. Additional openings spaced not more than 16 inches on centers shall be provided where grouting of all hollow unit masonry is indicated. Openings shall not be less than 4 inches in diameter or 3 by 4 inches in horizontal dimensions. Upon completion of grouting operations, grouting holes shall be plugged and finished to match surrounding surfaces.

3.12.3.2 Cleanouts for Hollow Unit Masonry Construction

Cleanout holes shall be provided at the bottom of every pour in cores containing vertical reinforcement when the height of the grout pour exceeds 5 feet. Where all cells are to be grouted, cleanout courses shall be constructed using bond beam units in an inverted position to permit cleaning of all cells. Cleanout holes shall be provided at a maximum spacing of 32 inches where all cells are to be filled with grout. A new series of cleanouts shall be established if grouting operations are stopped for more than 4 hours. Cleanouts shall not be less than 3 by 4 inch openings cut from one face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Cleanout holes shall not be closed until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, cleanout holes shall be closed in an approved manner to match surrounding masonry.

3.12.3.3 Cleanouts for Solid Unit Masonry Construction

Cleanouts for construction of walls consisting of a grout filled cavity between solid masonry wythes shall be provided at the bottom of every pour by omitting every other masonry unit from one wythe. A new series of cleanouts shall be established if grouting operations are stopped for more than 4 hours. Cleanout holes shall not be plugged until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, cleanout holes shall be closed in an approved manner to match surrounding masonry.

3.12.4 Grouting Equipment

3.12.4.1   Grout Pumps

Pumping through aluminum tubes will not be permitted. Pumps shall be operated to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, waste materials and debris shall be removed from the equipment, and disposed of outside the masonry.

3.12.4.2   Vibrators

Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. At least one spare vibrator shall be maintained at the site at all times. Vibrators shall be applied at uniformly spaced points not further apart than the visible effectiveness of the machine. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing segregation.

3.12.5   Grout Placement

Masonry shall be laid to the top of a pour before placing grout. Grout shall not be placed in two-wythe solid unit masonry cavity until mortar joints have set for at least 3 days during hot weather and 5 days during cold damp weather. Grout shall not be placed in hollow unit masonry until mortar joints have set for at least 24 hours. Grout shall be placed using a hand bucket, concrete hopper, or grout pump to completely fill the grout spaces without segregation of the aggregates. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. The height of grout pours and type of grout used shall be limited by the dimensions of grout spaces as indicated in Table III. Low-lift grout methods may be used on pours up to and including 5 feet in height. High-lift grout methods shall be used on pours exceeding 5 feet in height.

3.12.5.1   Low-Lift Method

Grout shall be placed at a rate that will not cause displacement of the masonry due to hydrostatic pressure of the grout. Mortar protruding more than 1/2 inch into the grout space shall be removed before beginning the grouting operation. Grout pours 12 inches or less in height shall be consolidated by mechanical vibration or by puddling. Grout pours over 12 inches in height shall be consolidated by mechanical vibration and reconsolidated by mechanical vibration after initial water loss and settlement has occurred. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. Low-lift grout shall be used subject to the limitations of Table III.

3.12.5.2   High-Lift Method

Mortar droppings shall be cleaned from the bottom of the grout space and from reinforcing steel. Mortar protruding more than 1/4 inchinto the grout space shall be removed by dislodging the projections with a rod or stick as the work progresses. Reinforcing, bolts, and embedded connections shall be rigidly held in position before grouting is started. CMU units shall not be pre-wetted. Grout, from the mixer to the point of deposit in the grout space shall be placed as rapidly as practical by pumping and placing methods which will prevent segregation of the mix and cause a minimum of grout splatter on reinforcing and masonry surfaces not being immediately encased in the grout lift. The individual lifts of grout shall be limited to 4 feet in height. The first lift of grout shall be placed to a uniform height within the pour section and vibrated thoroughly to fill all voids. This first vibration shall follow immediately behind the pouring of the grout using an approved mechanical vibrator. After a waiting period sufficient to permit the grout to become plastic, but before it has taken any set, the succeeding lift shall be poured and vibrated 12 to 18 inches into the preceding lift. If the placing of the succeeding lift is going to be delayed beyond the period of workability of the preceding, each lift shall be reconsolidated by reworking with a second vibrator as soon as the grout has taken its settlement shrinkage. The waiting, pouring, and reconsolidation steps shall be repeated until the top of the pour is reached. The top lift shall be reconsolidated after the required waiting period. The high-lift grouting of any section of wall between vertical grout barriers shall be completed to the top of a pour in one working day unless a new series of cleanout holes is established and the resulting horizontal construction joint cleaned. High-lift grout shall be used subject to the limitations in Table III.

TABLE III

POUR HEIGHT AND TYPE OF GROUT FOR VARIOUS GROUT SPACE DIMENSIONS

			Minimum Dimensions of the Total Clear Areas Within Grout Spaces and Cells (in.) (1,2)	
Maximum Grout Pour Height (feet) (4)	Grout Type	Grouting Procedure	Multiwythe Masonry (3)	Hollow-unit Masonry
1	Fine	Low Lift	3/4	1-1/2 x 2
5	Fine	Low Lift	2	2 x 3
8	Fine	High Lift	2	2 x 3
12	Fine	High Lift	2-1/2	2-1/2 x 3
24	Fine	High Lift	3	3 x 3
1	Coarse	Low Lift	1-1/2	1-1/2 x 3
5	Coarse	Low Lift	2	2-1/2 x 3
8	Coarse	High Lift	2	3 x 3
12	Coarse	High Lift	2-1/2	3 x 3
24	Coarse	High Lift	3	3 x 4

Notes:

(1) The actual grout space or cell dimension must be larger than the sum of the following items:
a) The required minimum dimensions of total clear areas given in the table above;
b) The width of any mortar projections within the space;
c) The horizontal projections of the diameters of the horizontal reinforcing bars within a cross section of the grout space or cell.

(2) The minimum dimensions of the total clear areas shall be made up of one or more open areas, with at least one area being 3/4 inch or greater in width.

(3) For grouting spaces between masonry wythes.

(4) Where only cells of hollow masonry units containing reinforcement are grouted, the maximum height of the pour shall not exceed the distance between horizontal bond beams.

3.13 BOND BEAMS

****
NOTE: Bond beams that are continuous over openings will be reinforced to serve as lintels.
****

Bond beams shall be filled with grout and reinforced as indicated on the drawings. Grout barriers shall be installed under bond beam units to retain the grout as required. Reinforcement shall be continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated on the drawings. Where splices are required for continuity, reinforcement shall be lapped 48 bar diameters. A minimum clearance of 1/2 inch shall be maintained between reinforcement and interior faces of units.

3.14 CONTROL JOINTS

****
NOTE: Control joints will be located and detailed on the drawings. When control joint keys are required it is a Contractor's option to use either special control joint units or sash jamb units with control joint keys. If one is preferred over the other in the design, edit this paragraph accordingly and provide specific details on the drawings. When control joint keys are not required, fill head joints with mortar as detailed.
****

Control joints shall be provided as indicated and shall be constructed by using [mortar to fill the head joint] [special control-joint units] [sash jamb units with control joint key] [open end stretcher units] in accordance with the details shown on the drawings. Sash jamb units shall have a 3/4 by 3/4 inch groove near the center at end of each unit. The vertical mortar joint at control joint locations shall be continuous, including through all bond beams. This shall be accomplished by utilizing half blocks in alternating courses on each side of the joint. The control joint key shall be interrupted in courses containing continuous bond beam steel. In single wythe exterior masonry walls, the exterior control joints shall be raked to a depth of 3/4 inch; backer rod and sealant shall be installed in accordance with Section 07900 JOINT SEALING. Exposed interior control joints shall be raked to a depth of 1/4 inch. Concealed control joints shall be flush cut.

3.15 BRICK EXPANSION JOINTS AND CONCRETE MASONRY VENEER JOINTS

****
NOTE: Brick expansion joints and concrete masonry veneer joints will be located and detailed on the drawings.
****

Brick expansion joints and concrete masonry veneer joints shall be provided and constructed as shown on the drawings. Joints shall be kept free of mortar and other debris.

3.16 SHELF ANGLES

Shelf angles shall be adjusted as required to keep the masonry level and at the proper elevation. Shelf angles shall be galvanized. Shelf angles shall be provided in sections not longer than 10 feet and installed with a 1/4 inch gap between sections. Shelf angles shall be mitered and welded at building corners with each angle not shorter than 4 feet, unless limited by wall configuration.

3.17 LINTELS

3.17.1 Masonry Lintels

Masonry lintels shall be constructed with lintel units filled solid with grout in all courses and reinforced with a minimum of two No. 4 bars in the bottom course unless otherwise indicated on the drawings. Lintel reinforcement shall extend beyond each side of masonry opening 40 bar diameters or 24 inches, whichever is greater. Reinforcing bars shall be supported in place prior to grouting and shall be located 1/2 inch above the bottom inside surface of the lintel unit.

3.17.2 Precast Concrete and Steel Lintels

Precast concrete and steel lintels shall be as shown on the drawings. Lintels shall be set in a full bed of mortar with faces plumb and true. Steel and precast lintels shall have a minimum bearing length of 8 inches unless otherwise indicated on the drawings.

3.18 SILLS AND COPINGS

Sills and copings shall be set in a full bed of mortar with faces plumb and true.

3.19 ANCHORAGE TO CONCRETE AND STRUCTURAL STEEL

****

NOTE: If spacing of anchors varies from that specified, edit these paragraphs accordingly.

****

3.19.1 Anchorage to Concrete

Anchorage of masonry to the face of concrete columns, beams, or walls shall be with dovetail anchors spaced not over 16 inches on centers vertically and 24 inches on center horizontally.

3.19.2 Anchorage to Structural Steel

Masonry shall be anchored to vertical structural steel framing with adjustable steel wire anchors spaced not over 16 inches on centers vertically, and if applicable, not over 24 inches on centers horizontally.

3.20 PARGING

****

NOTE: If parging is not required, or if other types of dampproofing are in the project, this paragraph will be deleted.

****

The outside face of below-grade exterior concrete-masonry unit walls enclosing usable rooms and spaces, except crawl spaces, shall be parged with type S mortar. Parging shall not be less than 1/2 inchthick troweled to a smooth dense surface so as to provide a continuous unbroken shield from top of footings to a line 6 inchesbelow adjacent finish grade, unless otherwise indicated. Parging shall be coved at junction of wall and footing. Parging shall be damp-cured for 48 hours or more before backfilling. Parging shall be protected from freezing temperatures until hardened.

3.21 INSULATION

Anchored veneer walls shall be insulated, where shown, by installing board-type insulation on the cavity side of the inner wythe. Board type insulation shall be applied directly to the masonry or thru-wall flashing with adhesive. Insulation shall be neatly fitted between obstructions without impaling of insulation on ties or anchors. The insulation shall be applied in parallel courses with vertical joints breaking midway over the course below and shall be applied in moderate contact with adjoining units without forcing, and shall be cut to fit neatly against adjoining surfaces.

3.22 SPLASH BLOCKS

Splash blocks shall be located as shown.

3.23 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, mortar and grout daubs or splashings shall be completely removed from masonry-unit surfaces that will be exposed or painted. Before completion of the work, defects in joints of masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Immediately after grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high pressure stream of water and a stiff bristled brush. Masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Masonry surfaces shall be left clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

3.23.1 Concrete Masonry Unit and Concrete Brick Surfaces

Exposed concrete masonry unit and concrete brick surfaces shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.23.2 Clay or Shale Brick Surfaces

Exposed clay or shale brick masonry surfaces shall be cleaned as necessary to obtain surfaces free of stain, dirt, mortar and grout daubs, efflorescence, and discoloration or scum from cleaning operations. After cleaning, the sample panel of similar material shall be examined for discoloration or stain as a result of cleaning. If the sample panel is discolored or stained, the method of cleaning shall be changed to assure that the masonry surfaces in the structure will not be adversely affected. The exposed masonry surfaces shall be water-soaked and then cleaned with a solution proportioned 1/2 cup trisodium phosphate and 1/2 cup laundry detergent to one gallon of water or cleaned with a proprietary masonry cleaning agent specifically recommended for the color and texture by the clay products manufacturer. The solution shall be applied with stiff fiber brushes, followed immediately by thorough rinsing with clean water. Proprietary cleaning agents shall be used in conformance with the cleaning product manufacturer's printed recommendations. Efflorescence shall be removed in conformance with the brick manufacturer's recommendations.

3.23.3 Prefaced Concrete Masonry Unit Surfaces

Prefaced concrete masonry unit surfaces shall be cleaned with soap powder and clean water applied with stiff fiber brushes. Excess mortar shall be removed with wood paddles. Metal cleaning tools, metal brushes, abrasive powders, and acid solutions shall not be used. At the completion of cleaning operations, the surfaces shall be rinsed with clean water. In areas of traffic within the building, a barricade of wood supported by framing lumber shall be erected to protect the units. In other areas, a heavy kraft-type building paper shall be taped over the units until final acceptance.

3.24 BEARING PLATES

****

NOTE: The bearing details must be shown on the drawings. The thermal effects must be considered for steel beams bearing on masonry to prevent cracking of masonry walls due to thermal expansion of steel framing members.

****

Bearing plates for beams, joists, joist girders and similar structural members shall be set to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated. Bedding mortar and non-shrink grout shall be as specified in Section 03300CAST-IN-PLACE STRUCTURAL CONCRETE.

3.25 PROTECTION

Facing materials shall be protected against staining. Top of walls shall be covered with nonstaining waterproof covering or membrane when work is not in progress. Covering of the top of the unfinished walls shall continue until the wall is waterproofed with a complete roof or parapet system. Covering shall extend a minimum of 2 feet down on each side of the wall and shall be held securely in place. Before starting or resuming, top surface of masonry in place shall be cleaned of loose mortar and foreign material.

3.26 TEST REPORTS

3.26.1 Field Testing of Mortar

****

NOTE: Delete this paragraph for structures having 185 square meters (2,000 square feet) or less of wall area, including openings. See TM 5-809-3 and ASTM C 780 for evaluating mortar test results.

****

At least three specimens of mortar shall be taken each day. A layer of mortar 1/2 to 5/8 inch thick shall be spread on the masonry units and allowed to stand for one minute. The specimens shall then be prepared and tested for compressive strength in accordance with ASTM C 780.

3.26.2 Field Testing of Grout

****
NOTE: Delete this paragraph for structures having 185 square meters (2,000 square feet) or less of wall area, including openings.
****

Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C 1019. A minimum of three specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 2000 psi at 28 days.

3.26.3 Efflorescence Test

****
NOTE: Delete this paragraph in areas where efflorescence has not been a problem. Efflorescence is generally the result of poor design and detailing. Properly covered or flashed walls are generally free of efflorescence. Efflorescence testing is generally not required.
****

Brick which will be exposed to weathering shall be tested for efflorescence. Tests shall be scheduled far enough in advance of starting masonry work to permit retesting if necessary. Sampling and testing shall conform to the applicable provisions of ASTM C 67. Units meeting the definition of "effloresced" will be subject to rejection.

3.26.4 Prism Tests

****
NOTE: Prism testing will only be required for structures requiring masonry compressive strengths higher than the assumed value of 9.3 MPa (1350 psi). Prism testing normally will not be required. Delete this paragraph when prism testing is not required.
****

At least one prism test sample shall be made for each 5,000 square feet of wall but not less than three such samples shall be made for any building. Three prisms shall be used in each sample. Prisms shall be tested in accordance with ASTM E 447. Seven-day tests may be used provided the relationship between the 7- and 28-day strengths of the masonry is established by the tests of the materials used. Compressive strength shall not be less than [_____] psi at 28 days. If the compressive strength of any prism falls below the specified value by more than 500 psi, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. If the likelihood of low-strength masonry is confirmed and computations indicate that the load-carrying capacity may have been significantly reduced, tests of cores drilled, or prisms sawed, from the area in question may be required. In such case, three specimens shall be taken for each prism test more than 500 psi below the specified value. Masonry in the area in question shall be considered structurally adequate if the average compressive strength of three specimens is equal to at least 85 percent of the specified value, and if the compressive strength of no single specimen is less than 75 percent of the specified value. Additional testing of specimens extracted from locations represented by erratic core or prism strength test results shall be permitted.

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-05090 (September 1998)**
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Superseding
CEGS-05055 (November 1988)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

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U.S. ARMY CORPS OF ENGINEERS **---------------------------**
Superseding
CEGS-05055 (November 1988)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 05090

WELDING, STRUCTURAL
09/98

****
NOTE: This guide specification covers the requirements for welding of structural steel for buildings bridges and other structures. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: This specification can be used for bridges and other structures with similar types of live loads by implementing the requirements of AWS D1.1, Section 9 or 10, as applicable, in the design of the weldments, and deleting the references to AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than

provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC-04	(1989) Specification for Structural Steel Buildings - Allowable Stress Design, Plastic Design

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT-01	(1996) Recommended Practice SNT-TC-1A

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1993) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0	(1994) Standard Welding Terms and Definitions
AWS D1.1	(1996) Structural Welding Code - Steel
AWS Z49.1	(1994) Safety in Welding and Cutting and Allied Processes

1.2 DEFINITIONS

Definitions of welding terms shall be in accordance with AWS A3.0.

1.3 GENERAL REQUIREMENTS

****
NOTE: The drawings should be checked to ensure that any supplementary information required by the paragraph has been shown and that there is no conflict between the drawings and the specifications. Complete information about location, type, size, and extent of all welds and nondestructive testing, where required, shall be clearly shown on the drawings. When welding is to be covered by more than one section in the contract specifications, this section will cover all structural welding; the other sections will cover the utilities or special equipment required inside the structure. Welding of utilities or special equipment to structural members should be done carefully so that the overall structure is not weakened. The extent of welding required must be clearly shown on drawings or covered by the contract specification. Revise this paragraph to clearly define the welding that is covered. Drawings or

other section of the specifications must specify the strength of the base material.

Drawings or the text of the contract specifications must specify the weld requirements: tensile strength, elongation, shear strength, size, length, type, and location.
****

The design of welded connections shall conform to AISC-04 unless otherwise indicated or specified. Material with welds will not be accepted unless the welding is specified or indicated on the drawings or otherwise approved. Welding shall be as specified in this section, except where additional requirements are shown on the drawings or are specified in other sections. Welding shall not be started until welding procedures, welders, welding operators, and tackers have been qualified and the submittals approved by the Contracting Officer. Qualification testing shall be performed at or near the work site. Each Contractor performing welding shall maintain records of the test results obtained in welding procedure, welder, welding operator, and tacker performance qualifications.

1.4 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Welding Procedure Qualifications; [_____].

Welder, Welding Operator, and Tacker Qualification; [_____].

Inspector Qualification; [_____].

Copies of the welding procedure specifications; the procedure qualification test records; and the welder, welding operator, or tacker qualification test records.

SD-18 Records

Quality Control; [_____].

A quality assurance plan and records of tests and inspections.

1.5 WELDING PROCEDURE QUALIFICATIONS

****

NOTE: Drawings or the text of the contract specifications must specify the weld requirements: tensile strength, elongation, shear strength, size, length, type, and location.

When the proposed shielded metal-arc welding procedures are reviewed, the voltage and travel speed should be within the limits shown in the following table:

Electrode	Voltage Limits	Travel Speed Limits
E6010	28 - 32	125 - 380 mm/minute (5 - 15 inch/minute)
E6011	28 - 32	150 - 300 mm/minute (6 - 12 inch/minute)
E6013	22 - 26	200 - 360 mm/minute (8 - 14 inch/minute)
E7018	25 - 28	150 - 510 mm/minute (6 - 20 inch/minute)
E7024	26 - 32	200 - 410 mm/minute (8 - 16 inch/minute)
E8018	22 - 28	200 - 510 mm/minute (8 - 20 inch/minute)
E11018	25 - 30	150 - 410 mm/minute (6 - 16 inch/minute)

These limits are for 3.0 mm (1/8 inch) diameter electrodes and the voltage will vary a small amount (plus or minus 2 volts) with different diameters. The travel speed limits will remain constant. The current limits, which are based on coating types and core wire diameter, should be as designated in AWS A5.1. The heat input, measured in Joules per mm (Joules per inch),

(Voltage x Current x 60)/(Travel speed inch/minute)

This should not exceed 2,165 Joules per mm (55,000 Joules per inch) for A36 steel. With higher heat inputs, the weld metal strengths fall below the specification limits. For gas metal-arc welding, the maximum heat input should be 1,969 Joules per mm

(50,000 Joules per inch).
****

Except for prequalified (per AWS D1.1) and previously qualified procedures, each Contractor performing welding shall record in detail and shall qualify the welding procedure specification for any welding procedure followed in the fabrication of weldments. Qualification of welding procedures shall conform to AWS D1.1 and to the specifications in this section. Copies of the welding procedure specification and the results of the procedure qualification test for each type of welding which requires procedure qualification shall be submitted for approval. Approval of any procedure, however, will not relieve the Contractor of the sole responsibility for producing a finished structure meeting all the requirements of these specifications. This information shall be submitted on the forms in Appendix E of AWS D1.1. Welding procedure specifications shall be individually identified and shall be referenced on the detail drawings and erection drawings, or shall be suitably keyed to the contract drawings. In case of conflict between this specification and AWS D1.1, this specification governs.

1.5.1 Previous Qualifications

Welding procedures previously qualified by test may be accepted for this contract without requalification if the following conditions are met:

a. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.

b. The qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.

c. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

1.5.2 Prequalified Procedures

Welding procedures which are considered prequalified as specified in AWS D1.1 will be accepted without further qualification. The Contractor shall submit for approval a listing or an annotated drawing to indicate the joints not prequalified. Procedure qualification shall be required for these joints.

1.5.3 Retests

If welding procedure fails to meet the requirements of AWS D1.1, the procedure specification shall be revised and requalified, or at the Contractor's option, welding procedure may be retested in accordance with AWS D1.1. If the welding procedure is qualified through retesting, all test results, including those of test welds that failed to meet the requirements, shall be submitted with the welding procedure.

1.6 WELDER, WELDING OPERATOR, AND TACKER QUALIFICATION

****

NOTE: Additional requirements may be inserted if necessary. The methods of nondestructive testing required will be determined and specified.

****

Each welder, welding operator, and tacker assigned to work on this contract shall be qualified in accordance with the applicable requirements of AWS D1.1 and as specified in this section. Welders, welding operators, and tackers who make acceptable procedure qualification test welds will be considered qualified for the welding procedure used.

1.6.1 Previous Qualifications

At the discretion of the Contracting Officer, welders, welding operators, and tackers qualified by test within the previous 6 months may be accepted for this contract without requalification if all the following conditions are met:

a. Copies of the welding procedure specifications, the procedure qualification test records, and the welder, welding operator, and tacker qualification test records are submitted and approved in accordance with the specified requirements for detail drawings.

b. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.

c. The previously qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.

d. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

1.6.2 Certificates

Before assigning any welder, welding operator, or tacker to work under this contract, the Contractor shall submit the names of the welders, welding operators, and tackers to be employed, and certification that each individual is qualified as specified. The certification shall state the type of welding and positions for which the welder, welding operator, or tacker is qualified, the code and procedure under which the individual is qualified, the date qualified, and the name of the firm and person certifying the qualification tests. The certification shall be kept on file, and 3 copies shall be furnished. The certification shall be kept current for the duration of the contract.

1.6.3 Renewal of Qualification

Requalification of a welder or welding operator shall be required under any of the following conditions:

a. It has been more than 6 months since the welder or welding operator has used the specific welding process for which he is qualified.

b. There is specific reason to question the welder or welding operator's ability to make welds that meet the requirements of these specifications.

c. The welder or welding operator was qualified by an employer other than those firms performing work under this contract, and a qualification test has not been taken within the past 12 months. Records showing periods of employment, name of employer where welder, or welding operator, was last employed, and the process for which qualified shall be submitted as evidence of conformance.

d. A tacker who passes the qualification test shall be considered eligible to perform tack welding indefinitely in the positions and with the processes for which he is qualified, unless there is some specific reason to question the tacker's ability. In such a case, the tacker shall be required to pass the prescribed tack welding test.

1.7 INSPECTOR QUALIFICATION

****
NOTE: Additional requirements may be inserted if necessary. The methods of nondestructive testing required will be determined and specified. If quality control inspection is to be the responsibility of the Government, delete this paragraph.
****

Inspection and nondestructive testing personnel shall be qualified in accordance with the requirements of ASNT-01 for Levels I or II in the applicable nondestructive testing method. The inspector may be supported by assistant welding inspectors who are not qualified to ASNT-01, and assistant inspectors may perform specific inspection functions under the supervision of the qualified inspector.

1.8 SYMBOLS

Symbols shall be in accordance with AWS A2.4, unless otherwise indicated.

1.9 SAFETY

Safety precautions during welding shall conform to AWS Z49.1.

PART 2 PRODUCTS

2.1 WELDING EQUIPMENT AND MATERIALS

****
NOTE: Normally, the Contractor (fabricator) selects the specific electrode material for weldments. In all cases, a class of electrode should be called out based on the table of matching filler metals in AWS D1.1. If in special cases the selection of the proper electrode is critical to the design, the designer may specify the electrode to be used in this or other sections. In special cases, it may also be necessary to specify the welding process.
****

All welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator performing qualified welding procedures. All welding equipment and materials shall comply with the applicable requirements of AWS D1.1.

PART 3   EXECUTION

3.1   WELDING OPERATIONS

****
NOTE: When the proposed shielded metal-arc welding procedures are reviewed, the voltage and travel speed should be within the limits shown in the following table:

Electrode	Voltage Limits	Travel Speed Limits
E6010	28 - 32	125 - 380 mm/minute (5 - 15 inch/minute)
E6011	28 - 32	150 - 300 mm/minute (6 - 12 inch/minute)
E6013	22 - 26	200 - 360 mm/minute (8 - 14 inch/minute)
E7018	25 - 28	150 - 510 mm/minute (6 - 20 inch/minute)
E7024	26 - 32	200 - 410 mm/minute (8 - 16 inch/minute)
E8018	22 - 28	200 - 510 mm/minute (8 - 20 inch/minute)
E11018	25 - 30	150 - 410 mm/minute (6 - 16 inch/minute)

These limits are for 3.0 mm (1/8 inch) diameter electrodes and the voltage will vary a small amount (plus or minus 2 volts) with different diameters. The travel speed limits will remain constant. The current limits, which are based on coating types and core wire diameter, should be as designated in AWS A5.1. The heat input, measured in Joules per mm (Joules per inch),

(Voltage x Current x 60)/(Travel speed inch/minute).

This should not exceed 2,165 Joules per mm (55,000 Joules per inch) for A36 steel. With higher heat inputs, the weld metal strengths fall below the specification limits. For gas metal-arc welding, the maximum heat input should be 1,969 Joules per mm (50,000 Joules per inch).
****

3.1.1   Requirements

Workmanship and techniques for welded construction shall conform to the requirements of AWS D1.1 and AISC-04. When AWS D1.1 and the AISC-04 specification conflict, the requirements of AWS D1.1 shall govern.

3.1.2 Identification

Welds shall be identified in one of the following ways:

a. Written records shall be submitted to indicate the location of welds made by each welder, welding operator, or tacker.

b. Each welder, welding operator, or tacker shall be assigned a number, letter, or symbol to identify welds made by that individual. The Contracting Officer may require welders, welding operators, and tackers to apply their symbol next to the weld by means of rubber stamp, felt-tipped marker with waterproof ink, or other methods that do not cause an indentation in the metal. For seam welds, the identification mark shall be adjacent to the weld at 3 foot intervals. Identification with die stamps or electric etchers shall not be allowed.

3.2 QUALITY CONTROL

****

NOTE: The methods of nondestructive testing required will be determined and specified. The specification writer (designer) must decide what weld defects can be tolerated under service conditions. Next, the type of nondestructive examination (NDE) system to be used must be determined, considering joint design, material thickness, and accessibility to the joint. Every weld joint will not require 100 percent NDE. Joints critical to the structure should be determined. These should be inspected more closely than noncritical joints. Remember, visual inspection is as important to the final quality of the weld as the other methods. The specifications or drawings must clearly indicate which joints require 100 percent NDE, which joints require random inspection, and which method(s) are to be used for each joint. For random inspection, the drawings must indicate the location, number of joints, and minimum increment length of weld which will be inspected, but must not disclose the exact spot to be examined. Joints not inspected by radiographic, magnetic particle, liquid penetrant, or ultrasonic methods shall be subject to visual inspections only. If quality control is to be primarily the Contractor's responsibility and the inspection and tests are adequately called out, then acceptance by the Government can rely on the Contractor's work and records -- with some spot checking to verify the results. On projects with only a small amount of welding that needs just visual inspection, acceptance inspection by the Government may be the only quality control required.

Additional requirements may be inserted if necessary. The methods of nondestructive testing required will be determined and specified. If quality control inspection is to be the responsibility of the Government, delete this paragraph.

If the Contractor must do radiographic or nondestructive inspection other than visual, or inspection other than that covered by Section 6 of AWS D1.1, these requirements must be added to this paragraph. The extent of inspection must be clearly shown either on the drawings or by this or other sections of the specifications. The bracketed portion of the paragraph must be edited to define the extent of nondestructive testing required.
****

Testing shall be done by an approved inspection or testing laboratory or technical consultant; or if approved, the Contractor's inspection and testing personnel may be used instead of the commercial inspection or testing laboratory or technical consultant. The Contractor shall perform visual [and] [radiographic,] [ultrasonic,] [magnetic particle,] [and] [dye penetrant] inspection to determine conformance with paragraph STANDARDS OF ACCEPTANCE. Procedures and techniques for inspection shall be in accordance with applicable requirements of AWS D1.1, except that in radiographic inspection only film types designated as "fine grain," or "extra fine," shall be employed.

3.3 STANDARDS OF ACCEPTANCE

****
NOTE: Drawings or the text of the contract specifications must specify the weld requirements: tensile strength, elongation, shear strength, size, length, type, and location.
****

Dimensional tolerances for welded construction, details of welds, and quality of welds shall be in accordance with the applicable requirements of AWS D1.1 and the contract drawings. Nondestructive testing shall be by visual inspection [and radiographic,] [ultrasonic,] [magnetic particle,] [or] [dye penetrant] methods. The minimum extent of nondestructive testing shall be random [_____] percent of welds or joints, as indicated on the drawings.

3.3.1 Nondestructive Examination

The welding shall be subject to inspection and tests in the mill, shop, and field. Inspection and tests in the mill or shop will not relieve the Contractor of the responsibility to furnish weldments of satisfactory quality. When materials or workmanship do not conform to the specification requirements, the Government reserves the right to reject material or workmanship or both at any time before final acceptance of the structure containing the weldment.

3.3.2 Destructive Tests

When metallographic specimens are removed from any part of a structure, the Contractor shall make repairs. The Contractor shall employ qualified welders or welding operators, and shall use the proper joints and welding procedures, including peening or heat treatment if required, to develop the full strength of the members and joints cut and to relieve residual stress.

3.4 GOVERNMENT INSPECTION AND TESTING

In addition to the inspection and tests performed by the Contractor for quality control, the Government will perform inspection and testing for acceptance to the extent determined by the Contracting Officer. The costs of such inspection and testing will be borne by the Contractor if unsatisfactory welds are discovered, or by the Government if the welds are satisfactory. The work may be performed by the Government's own forces or under a separate contract for inspection and testing. The Government reserves the right to perform supplemental nondestructive and destructive tests to determine compliance with paragraph STANDARDS OF ACCEPTANCE.

3.5 CORRECTIONS AND REPAIRS

When inspection or testing indicates defects in the weld joints, the welds shall be repaired using a qualified welder or welding operator as applicable. Corrections shall be in accordance with the requirements of AWS D1.1 and the specifications. Defects shall be repaired in accordance with the approved procedures. Defects discovered between passes shall be repaired before additional weld material is deposited. Wherever a defect is removed and repair by welding is not required, the affected area shall be blended into the surrounding surface to eliminate sharp notches, crevices, or corners. After a defect is thought to have been removed, and before rewelding, the area shall be examined by suitable methods to ensure that the defect has been eliminated. Repair welds shall meet the inspection requirements for the original welds. Any indication of a defect shall be regarded as a defect, unless reevaluation by nondestructive methods or by surface conditioning shows that no unacceptable defect is present.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-05120 (September 1997)**
U.S. ARMY CORPS OF ENGINEERS **---------------------------**
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GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 2 (April 1999)

Latest change indicated by CHG tags
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****

SECTION 05120

STRUCTURAL STEEL
09/97

****

NOTE: This guide specification covers the requirements for structural steel for buildings and other structures. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC FCD	(1995a) Quality Certification Program Description
AISC ASD Mnl	(1989) Manual of Steel Construction Allowable Stress Design
AISC ASD/LRFD Vol II	(1992) Manual of Steel Construction Vol II: Connections
AISC Design Guide #10	(1989) Erection Bracing of Low-Rise Structural Steel Frames
AISC LRFD Vol I	(1995) Manual of Steel Construction Load & Resistance Factor Design, Vol I: Structural Members, Specifications & Codes
AISC LRFD Vol II	(1995) Manual of Steel Construction Load & Resistance Factor Design, Vol II: Structural Members, Specifications & Codes
AISC Pub No. S303	(1992) Code of Standard Practice for Steel Buildings and Bridges

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6/A 6M	(1997) General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A 36/A 36M	(1996) Carbon Structural Steel
ASTM A 53	(1997) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 242/A 242M	(1993a) High-Strength Low-Alloy Structural Steel
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 325M	(1993) High-Strength Bolts for Structural Steel Joints (Metric)
ASTM A 490	(1997) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
ASTM A 490M	(1993) High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM A 500	(1996) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds

	and Shapes
ASTM A 501	(1996) Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 502	(1993) Steel Structural Rivets
ASTM A 514/A 514M	(1994a) High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A 529/A 529M	(1996) High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A 563	(1996) Carbon and Alloy Steel Nuts
ASTM A 563M	(1996) Carbon and Alloy Steel Nuts (Metric)
ASTM A 572/A 572M	(1997) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 588/A 588M	(1997) High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 in. (100 mm) Thick
ASTM A 618	(1996) Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
ASTM A 709/A 709M	(19997a) Carbon and High-Strength Low-Alloy Structural Steel Shapes, Plates, and Bars and Quenched-and-Tempered Alloy Structural Steel Plates for Bridges
ASTM A 852/A 852M	(1997) Quenched and Tempered Low-Alloy Structural Steel Plate with 70 ksi (485 MPa) Minimum Yield Strength to 4 in. (100 mm) Thick
ASTM F 436	(1993) Hardened Steel Washers
ASTM F 436M	(1993) Hardened Steel Washers (Metric)
ASTM F 844	(1990) Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F 959	(1996) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.21.1	(1994) Lock Washers (Inch Series)
ASME B46.1	(1995) Surface Texture (Surface Roughness, Waviness, and Lay)

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1993) Standard Symbols for Welding,

	Brazing and Nondestructive Examination
AWS D1.1	(1996) Structural Welding Code - Steel

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (without Lead and Chromate Pigments)

1.2 GENERAL REQUIREMENTS

****

NOTE: The design of structural members, whether prepared by an A-E or in house, will be checked for adequacy. The designs and detail drawings submitted by the Contractor will be checked against the accepted design; drawings of structural connections will require Government approval. The Government designer has final responsibility for the adequacy of the structural members and their connections including simple connections.

The design should be checked to ensure that adequate supports at appropriate spacings have been provided for the installation of piping, expansion tanks, unit heaters, suspended ceilings and similar items.

Where welding is for critical applications, the specification will be revised to include a reference to Section 05055 WELDING, STRUCTURAL.

Provisions for using self-locking nuts should be considered where shock or vibration would be a problem.

Structural design may be accomplished following either the Allowable Stress Design (ASD) method or the Load and Resistance Factor Design (LRFD) method. When the ASD method is used, publications AISC ASD Mnl and AISC ASD/LRFD Vol II will be retained. When the LRFD method is used, publications AISC LRFD Vol I and AISC LRFD Vol II will be retained.

****

Structural steel fabrication and erection shall be performed by an organization experienced in structural steel work of equivalent magnitude. The Contractor shall be responsible for correctness of detailing, fabrication, and for the correct fitting of structural members. Connections, for any part of the structure not shown on the contract drawings, shall be considered simple shear connections and shall be designed and detailed in accordance with pertinent provisions of AISC ASD Mnl and AISC LRFD Vol II. Substitution of sections or modification of connection details will not be accepted unless approved by the Contracting Officer. [AISC ASD Mnl and AISC ASD/LRFD Vol II] [AISC LRFD Vol I and AISC LRFD Vol II] shall govern the work. Welding shall be in accordance with

AWS D1.1. High-strength bolting shall be in accordance with [AISC ASD Mnl] [AISC LRFD Vol I].

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Structural Steel System; [_____]. Structural Connections; GA.

Shop and erection details including members (with their connections) not shown on the contract drawings. Welds shall be indicated by standard welding symbols in accordance with AWS A2.4.

SD-08 Statements

Erection; [_____].

Prior to erection, erection plan of the structural steel framing describing all necessary temporary supports, including the sequence of installation and removal.

SD-13 Certificates

Mill Test Reports; [_____].

Certified copies of mill test reports for structural steel, structural bolts, nuts, washers and other related structural steel items, including attesting that the structural steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified, prior to the installation.

Welder Qualifications; [_____].

Certified copies of welder qualifications test records showing qualification in accordance with AWS D1.1.

Fabrication; [_____].

A copy of the AISC certificate indicating that the fabrication plant meets the specified structural steelwork category.

SD-14 Samples

High Strength Bolts and Nuts; [_____]. Carbon Steel Bolts and Nuts; [_____]. Nuts Dimensional Style; [_____]. Washers; [_____].

Random samples of bolts, nuts, and washers as delivered to the job site if requested, taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

1.4 STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

PART 2 PRODUCTS

****

NOTE: Materials appropriate to the design will be selected and remaining materials will be deleted.

Designer should require materials, products, and innovative construction methods and techniques which are environmentally sensitive, take advantage of recycling and conserve natural resources.

****

2.1 STRUCTURAL STEEL

2.1.1 Carbon Grade Steel

Carbon grade steel shall conform to [ASTM A 36/A 36M] [ASTM A 529/A 529M].

2.1.2 High-Strength Low-Alloy Steel

High-strength low-alloy steel shall conform to ASTM A 572/A 572M, Grade [_____].

2.1.3 Corrosion-Resistant High-Strength Low-Alloy Steel

Corrosion-resistant steel shall conform to [ASTM A 242/A 242M] [ASTM A 588/A 588M].

2.1.4 Quenched and Tempered Alloy Steel

Tempered alloy steel shall conform to ASTM A 514/A 514M.

2.1.5 Carbon and High-Strength Low-Alloy Steel

Carbon and high-strength low-alloy steel shall conform to ASTM A 709/A 709M.

2.1.6 Quenched and Tempered Low-Alloy Steel

Quenched and tempered low-alloy steel shall conform to ASTM A 852/A 852M, 70 ksi.

2.2 STRUCTURAL TUBING

Structural tubing shall conform to [ASTM A 500, Grade [_____]] [ASTM A 501] [ASTM A 618, Grade [_____]].

2.3 STEEL PIPE

Steel pipe shall conform to ASTM A 53, [Type E] [Type S], Grade B.

2.4 RIVETS

Rivets shall conform to ASTM A 502, Grade [_____].

2.5 HIGH STRENGTH BOLTS AND NUTS

High strength bolts shall conform to [ASTM A 325, Type 1 with carbon steel nuts conforming to ASTM A 563, Grade [C] [DH]] [ASTM A 325, Type 3 with carbon steel nuts conforming to ASTM A 563, Grade C3] [ASTM A 490, Type [1] [2] with carbon steel nuts conforming to ASTM A 563, Grade DH] [ASTM A 490, Type 3 with carbon steel nuts conforming to ASTM A 563, Grade DH3].

2.6 CARBON STEEL BOLTS AND NUTS

Carbon steel bolts shall conform to ASTM A 307, Grade A with carbon steel nuts conforming to ASTM A 563, Grade A.

2.7 NUTS DIMENSIONAL STYLE

Carbon steel nuts shall be [Square] [Hex] [Heavy Hex] [Hex Thick] style when used with ASTM A 307 bolts or Heavy Hex style when used with ASTM A 325 or ASTM A 490 bolts.

2.8 WASHERS

Plain washers shall conform to ASTM F 844. Other types, when required, shall conform to [ASME B18.21.1] [ASTM F 436] [ASTM F 959].

2.9 PAINT

Paint shall conform to SSPC Paint 25.

PART 3 EXECUTION

3.1 FABRICATION

****

NOTE: If bearing-type high strength bolted connections are required, delete the painting exception for contact surfaces of friction-type high-strength bolted connections.

AISC fabrication plant certification is required for the structural steel to be furnished for the project. The requirement for AISC fabrication plant certification may be deleted at the discretion of the designer. This decision will be based on the complexity of the design and the criticality of the connections. If moment connections are involved, AISC certification is recommended. The quantity of

structural steel in the project should be a point of consideration. The certification categories, as defined in AISC FCD, are:

a. Conventional Steel Building Structures

b. Simple Steel Bridge Structures

c. Complex Steel Building Structures

d. Major Steel Bridges

e. Metal Building Systems.

f. Supplement: Auxiliary and Support Structures for Nuclear Power Plants - This supplement, applicable to nuclear plant structures designed under the AISC Specification, but not to pressure-retaining structures, offers utility companies and designers of nuclear power plants a certification program that will eliminate the need for many of the more costly, conflicting programs now in use.

****

Fabrication shall be in accordance with the applicable provisions of AISC ASD Mnl. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC FCD for Category [_____] [Supplement] structural steelwork. Compression joints depending on contact bearing shall have a surface roughness not in excess of 500 micro inches as determined by ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A 6/A 6M. Structural steelwork, except surfaces of steel to be encased in concrete, surfaces to be field welded, surfaces to be fireproofed, and contact surfaces of friction-type high-strength bolted connections shall be prepared for painting in accordance with [endorsement "P" of AISC FCD] [_____] and primed with the specified paint.

3.2 ERECTION

****

NOTE: For low-rise structural steel buildings, the designer must design the structure to be erected in accordance with AISC Design Guide #10.

****

a: Erection of structural steel, except as indicated in item b. below, shall be in accordance with the applicable provisions of [AISC ASD Mnl] [AISC LRFD Vol I] [endorsement F of AISC FCD]. Erection plan shall be reviewed, stamped and sealed by a structural engineer licensed by the state in which the project is located.

b. For low-rise structural steel buildings (60 feet tall or less and a maximum of 2 stories), the erection plan shall conform to AISC Pub No. S303 and the structure shall be erected in accordance with AISC Design Guide #10.

3.2.1 Structural Connections

Anchor bolts and other connections between the structural steel and foundations shall be provided and shall be properly located and built into connecting work. Field welded structural connections shall be completed before load is applied.

3.2.2 Base Plates and Bearing Plates

Column base plates for columns and bearing plates for beams, girders, and similar members shall be provided. Base plates and bearing plates shall be provided with full bearing after the supported members have been plumbed and properly positioned, but prior to placing superimposed loads. Separate setting plates under column base plates will not be permitted. The area under the plate shall be damp-packed solidly with bedding mortar, except where nonshrink grout is indicated on the drawings. Bedding mortar and grout shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.2.3 Field Priming

After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat shall be cleaned and primed with paint of the same quality as that used for the shop coat.

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-05210 (November 1988)**
U.S. ARMY CORPS OF ENGINEERS | **--------------------------**
Superseding
CEGS-05210 (April 1985)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 5 (March 1995)
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Latest Notice change indicated by CHG tags

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STEEL JOISTS

11/88

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SECTION 05210

STEEL JOISTS
11/88

****
NOTE: This guide specification covers the requirements for open web, long span steel joists and joist girders. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to in the text by basic designation only.

STEEL JOIST INSTITUTE (SJI)

SJI-01	(1994) Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

NOTE: Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Steel Joists; [_____].

Detail drawings shall include fabrication and erection details, specifications for shop painting, and identification markings of joists [and joist girders].

SD-13 Certificates

Steel Joists; [_____].

Certificates stating that the steel joists [and joist girders] have been designed and manufactured in accordance with SJI-01. Complete engineering design computations may be submitted in lieu of the certification.

1.3 DESCRIPTION

****

NOTE: Drawings will show size, spacing and method of anchoring. Size will be indicated by reference to appropriate SJI designations. Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between panel points in excess of 222 N (50 pounds) shall have the excess hanger loads suspended from panel points. When joists or girders are to be designed to resist uplift and/or lateral

forces, such joists and girders and the forces they must resist will be indicated on the drawings. Also, proper anchorages and bracings will be designed to resist those forces, as required. The standard joist tables cannot be used verbatim when the depth of the joist is reduced near the ends to accommodate two-way top chord slopes in excess of 10 mm per meter (l/8 inch per foot). Before using standard designations for these joists, the designer must verify the adequacy of the joist members.
****

Steel joists [and joist girders] are designated on the drawings in accordance with the standard designations of the Steel Joist Institute. Joists of other standard designations or joists with properties other than those shown may be substituted for the joists designated provided the structural properties are equal to or greater than those of the joists shown and provided all other specified requirements are met.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition and stored off the ground in a well drained location, protected from damage, and easily accessible for inspection and handling.

PART 2 PRODUCTS

2.1 OPEN WEB STEEL JOISTS

Open web steel joists shall conform to SJI-01, K-Series. Joists shall be designed to support the loads given in the standard load tables of SJI-01.

2.2 LONGSPAN STEEL JOISTS

[Longspan steel joists] [and] [deep longspan steel joists] shall conform to SJI-01, [LH-Series] [DLH-Series]. Joists designated [LH] [and] [DLH] shall be designed to support the loads given in the applicable standard load tables of SJI-01.

2.3 JOIST GIRDERS

Joist girders shall conform to SJI-01.

2.4 ACCESSORIES AND FITTINGS

Accessories and fittings, including end supports and bridging, shall be in accordance with the standard specifications under which the members were designed.

2.5 SHOP PAINTING

****
NOTE: The requirements of the paragraph will be coordinated with the requirements of Section 09900 PAINTING, GENERAL. In crawl spaces and other high humidity areas where greater protection than that provided by a primer paint is required and the joists or girders will not be finish painted, the

paragraph will be revised to require that the joists or girders be shop painted with an asphalt-base type paint.
****

Joists [, joist girders] and accessories shall be shop painted with a rust-inhibiting primer paint. For joists [and joist girders] which will be finish painted under Section 09900 PAINTING, GENERAL, the primer paint shall be limited to a primer which is compatible with the specified finish paint.

PART 3   EXECUTION

3.1   ERECTION

Installation of joists [and joist girders] shall be in accordance with the standard specification under which the member was produced. Joists [and joist girders] shall be handled in a manner to avoid damage. Damaged joists [and joist girders] shall be removed from the site, except when field repair is approved and such repairs are satisfactorily made in accordance with the manufacturer's recommendations. Joists [and joist girders] shall be accurately set, and end anchorage shall be in accordance with the standard specification under which the joists [and joist girders] were produced. For spans over 40 ft through 60 ft one row of bridging nearest midspan shall be bolted diagonal bridging; for spans over 60 ft bolted diagonal bridging shall be used instead of welded horizontal bridging. Joist bridging and anchoring shall be secured in place prior to the application of any construction loads. Any temporary loads shall be distributed so that the carrying capacity of any joist is not exceeded. Loads shall not be applied to bridging during construction or in the completed work. Abraded, corroded, and field welded areas shall be cleaned and touched up with the same type of paint used in the shop painting.

3.2   BEARING PLATES

Bearing plates shall be provided with full bearing after the supporting members have been plumbed and properly positioned, but prior to placing superimposed loads. The area under the plate shall be damp-packed solidly with bedding mortar, except where nonshrink grout is indicated on the drawings. Bedding mortar and grout shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

-- End of Section --

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DEPARTMENT OF THE ARMY — **CEGS-05300 (October 1989)**
U.S. ARMY CORPS OF ENGINEERS — **---------------------------**
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SECTION 05300

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10/89

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DEPARTMENT OF THE ARMY | **CEGS-05300 (October 1989)**
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SECTION 05300

STEEL DECKING
10/89

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NOTE: This guide specification covers the requirements for roof or floor steel deck construction. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC ASD Spec	(1989) Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI Cold-Formed Mnl	(1996) Cold-Formed Steel Design Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 108	(1995) Steel Bars, Carbon, Cold Finished, Standard Quality
ASTM A 570/A 570M	(1996) Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM A 611	(1997) Structural Steel (SS), Sheet, Carbon, Cold-Rolled
ASTM A 653/A 653M	(1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 780	(1993a) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM A 792/A 792M	(1997) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM C 423	(1990a) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM E 795	(1993) Mounting Test Specimens During Sound Absorption Tests

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1998) Structural Welding Code - Steel
AWS D1.3	(1998) Structural Welding Code - Sheet Steel

STEEL DECK INSTITUTE (SDI)

SDI Diaphram Mnl	(1987; Amended 1991) Diaphragm Design Manual
SDI Pub No 29	(1995) Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 20 (1991) Zinc-Rich Primers (Type I - Inorganic and Type II - Organic)

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Deck Units; [_____].

Design computations for the structural properties of the deck units or SDI certification that the units are designed in accordance with SDI specifications.

SD-04 Drawings

Deck Units; [_____]. Accessories; [_____]. Attachments; [_____]. Holes and Openings; [_____].

Drawings shall include type, configuration, structural properties, location, and necessary details of deck units, accessories, and supporting members; size and location of holes to be cut and reinforcement to be provided; location and sequence of welded [or fastener] connections; and the manufacturer's erection instructions.

SD-13 Certificates

Deck Units; [_____]. Attachments; [_____].

Manufacturer's certificates attesting that the decking material meets the specified requirements. Manufacturer's certificate attesting that the operators are authorized to use the low-velocity piston tool.

SD-14 Samples

Deck Units; [_____]. Accessories; [_____].

A 2 sq. ft. sample of the decking material to be used, along with a sample of each of the accessories used. A sample of acoustical material to be used shall be included.

SD-18 Records

Attachments; [_____].

Prior to welding operations, copies of qualified procedures and lists of names and identification symbols of qualified welders and welding operators.

1.3 DELIVERY, STORAGE, AND HANDLING

Deck units shall be delivered to the site in a dry and undamaged condition, stored off the ground with one end elevated, and stored under a weathertight covering permitting good air circulation. Finish of deck units shall be maintained at all times by using touch-up paint whenever necessary to prevent the formation of rust.

PART 2 PRODUCTS

2.1 DECK UNITS

****

NOTE: The steel deck shall be designed according to SDI Pub No 29 The steel deck specified in this guide specification will be used in conjunction with insulation and built-up roofing in accordance with TM 5-805-14, Roofing and Waterproofing, or will be used as a permanent form for concrete or as part of a composite deck assembly. Steel deck for lightweight concrete roofs is specified in Section 03340 ROOF DECKING, CAST-IN-PLACE LOW DENSITY CONCRETE. Drawings should show location and extent of steel deck, complete structural support including openings greater than 300 mm (12 inches), type and location of accessories, uniformly distributed live loads (positive and negative) in kPa (psf), thickness, and required values for section modulus and moment of inertia per mm (foot) of width. Moments of inertia and section modulus values will be designed based on procedures set forth in SDI Pub No 29. Steel decks used as diaphragms must meet the requirements of TM 5-809-10, Chapter 5. Subsystems for fire-rated construction, including roof deck, joists, insulation, built-in roofing, and ceiling material will be indicated. When the finished installations will be exposed to high humidity, seacoast atmosphere or corrosive chemical fumes special care in specifying the finish should be used and individual manufacturers should be consulted for the specific application. Where sprayed-on fireproofing is used only galvanized decking with a G90 coating will be allowed. ASTM A 653/A 653M, G90 coating should be specified in paragraphs Roof Deck, Composite Deck, and Form Deck. Notes on the drawings should indicate the attachment method to be used, and should give the size and spacing for perimeter, side lap, intermediate supports, and end lap attachments.

****

Deck units shall conform to SDI Pub No 29. Panels of maximum possible lengths shall be used to minimize end laps. Deck units shall be fabricated in lengths to span 3 or more supports with flush, telescoped, or nested 2 inchlaps at ends, and interlocking, or nested side laps, unless otherwise indicated. Deck with cross-sectional configuration differing from the units indicated may be used, provided that the properties of the proposed units, determined in accordance with AISI Cold-Formed Mnl, are equal to or greater than the properties of the units indicated and that the material will fit the space provided without requiring revisions to adjacent materials or systems.

2.1.1 Roof Deck

****

NOTE: The epoxy coating is expensive and should only be considered for corrosive environments where justified by a cost analysis.

****

Steel deck used in conjunction with insulation and built-up roofing shall conform to ASTM A 792/A 792M, ASTM A 611 or ASTM A 792/A 792M. Roof deck units shall be fabricated of [[0.0295] [_____] inch design thickness or thicker steel] [the steel design thickness required by the design drawings] and shall be [shop painted] [galvanized] [painted with an epoxy coating or equivalent applied to prime-coating in accordance with manufacturer's standard] [zinc-coated in conformance with ASTM A 653/A 653M, G90 coating class or aluminum-zinc coated in accordance with ASTM A 792/A 792M Coating Designation AZ55].

2.1.2 Acoustical Deck Units

****

NOTE: Noise reduction coefficient will be obtained from manufacturer's literature. The manufacturer's standard acoustical deck shall be provided where indicated.

****

Deck shall have a noise reduction coefficient of [_____] when measured in accordance with ASTM C 423 using ASTM E 795 Mounting Type F-25. Sound absorbing materials shall be either [glass fiber in roll or premolded form for acoustical steel deck (noncellular)] [and] [or] [glass fiber rigid strip for acoustical steel deck (cellular)] in accordance with manufacturer's standards.

2.1.3 Composite Deck

Deck to receive concrete as a filler or for composite deck assembly shall conform to ASTM A 653/A 653M or ASTM A 611. Deck used as the tension reinforcing in composite deck shall be fabricated of [[0.0295] [_____] inch design thickness or thicker steel] [the steel design thickness required by the design drawings], and shall be zinc-coated in conformance with ASTM A 653/A 653M, [G60][G90] coating class. Deck units used in composite deck shall have adequate embossment to develop mechanical shear bond to provide composite action between the deck and the concrete.

2.1.4 Form Deck

Deck used as a permanent form for concrete shall conform to ASTM A 653/A 653M or ASTM A 611. Deck used as a form for concrete shall be fabricated of [[0.015] [_____] inch design thickness or thicker steel] [the steel design thickness required by the design drawings], and shall be [painted with one coat of manufacturer's standard paint] [zinc-coated in conformance with ASTM A 653/A 653M, [G60][G90] coating class.]

2.1.5 Sump Pans

****

NOTE: Coordinate sump pans with type of roof drain specified.

****

Sump pans shall be provided for roof drains and shall be minimum 0.075 inch thick steel, [flat] [recessed] type. Sump pans shall be shaped to meet roof slope by the supplier or by a sheet metal specialist. Bearing flanges of sump pans shall overlap steel deck a minimum of 3 inches. Opening in bottom of pan shall be shaped, sized, and reinforced to receive roof drain.

2.1.6 Shear Connectors

****

NOTE: Designer shall determine the necessity for shear connectors as per AISC ASD Spec. Designer shall show the size, spacing, and location of the shear connectors.

****

Shear connectors shall be [headed stud type, ASTM A 108, Grade 1015 or 1020, cold finished carbon steel with dimensions complying with AISC ASD Spec] [and] [or] [strap type, ASTM A 570/A 570M, Grade D, hot-rolled carbon steel].

2.2 TOUCH-UP PAINT

Touch-up paint for shop-painted units shall be [of the same type used for the shop painting] [_____], and touch-up paint for zinc-coated units shall be [an approved galvanizing repair paint with a high-zinc dust content] [_____]. Welds shall be touched-up with paint conforming to SSPC Paint 20 in accordance with ASTM A 780. Finish of deck units and accessories shall be maintained by using touch-up paint whenever necessary to prevent the formation of rust.

2.3 ADJUSTING PLATES

Adjusting plates or segments of deck units shall be provided in locations too narrow to accommodate full-size units. As far as practical, the plates shall be the same thickness and configuration as the deck units.

2.4 CLOSURE PLATES

****

NOTE: Drawings shall show closures above interior partitions where required. On fire partitions, metal closures will be shown on both sides of the

wall.
****

2.4.1 Closure Plates for Roof Deck

Voids above interior walls shall be closed with sheet metal where shown. Open deck cells at parapets, end walls, eaves, and openings through roofs shall be closed with sheet metal. Sheet metal shall be same thickness as deck units.

2.4.2 Closure Plates for Composite Deck

The concrete shall be supported and retained at each floor level. Provide edge closures at all edges of the slab of sufficient strength and stiffness to support the wet concrete. Metal closures shall be provided for all openings in composite steel deck 1/4 inch and over, including but not limited to:

2.4.2.1 Cover Plates to Close Panels

Cover plates to close panel edge and end conditions and where panels change direction or abut. Butt joints in composite steel deck may receive a tape joint cover.

2.4.2.2 Column Closures to Close Openings

Column closures to close openings between steel deck and structural steel columns.

2.4.2.3 Sheet Metal

Where deck is cut for passage of pipes, ducts, columns, etc., and deck is to remain exposed, provide a neatly cut sheet metal collar to cover edges of deck. Do not cut deck until after installation of supplemental supports.

2.5 ACCESSORIES

The manufacturer's standard accessories shall be furnished as necessary to complete the deck installation. Metal accessories shall be of the same material as the deck and have minimum design thickness as follows: saddles, 0.0474 inch; welding washers, 0.0598 inch; cant strip, 0.0295 inch; other metal accessories, 0.0358 inch; unless otherwise indicated. Accessories shall include but not be limited to saddles, welding washers, cant strips, butt cover plates, underlapping sleeves, and ridge and valley plates.

PART 3 EXECUTION

3.1 ERECTION

****
NOTE: Use SDI Pub No 29 for all decks except those designed for diaphragm action. Use SDI-O2 for diaphragm-action decks.
****

Erection of deck and accessories shall be in accordance with [SDI Pub No 29] [SDI Diaphram Mnl] and the approved detail drawings. Damaged deck and accessories including material which is permanently stained or contaminated, with burned holes or deformed shall not be installed. The deck units shall be placed on secure supports, properly adjusted, and aligned at right angles to supports before being permanently secured in place. The deck shall not be [filled with concrete,] used for storage or as a working platform until the units have been secured in position. [Shoring shall be in position before concrete placement begins in composite or form deck.] Loads shall be distributed by appropriate means to prevent damage during construction and to the completed assembly. The maximum uniform distributed storage load shall not exceed the design live load. There shall be no loads suspended directly from the steel deck. [Acoustical material shall be neatly fitted into the rib voids.]

3.2 SHORING

****

NOTE: The designer must determine if there are shoring requirements for composite decks. For most applications the design is selected so that shoring is not required. Shoring requirements shall be detailed on the design drawings.

****

Shoring requirements for placing and curing of concrete in the composite floor [and roof] deck assemblies shall be as shown.

3.3 ATTACHMENTS

****

NOTE: The option to fasten steel deck by screws, powder actuated fasteners, or pneumatically driven fasteners will be limited to areas of low seismic activity and to areas with a wind velocity of less than 160 km/hour (100 mph). However, based upon the submittal of supporting calculations and data to substantiate that such fasteners can resist the design loads, and approval of the Contracting Officer, fasteners may be used in all seismic areas and in areas with wind velocity of 160 km/hour (100 mph) or more. The required supporting calculations and data will be based upon the guidance provided in TI 809-04 Seismic Design for Buildings and the Steel Deck Institute's Diaphragm Design Manual (First and Second Editions), taking into account the type, size, length and spacing of the tested fasteners as well as the thickness and shape of the steel deck in order to determine the ability to resist the design loads (lateral and uplift). The fasteners shall provide minimum required pull-out, pull-over and shear resistance based upon test results of the specific steel deck and fastener as listed in the current edition of the Factory Mutual Approval Guide and Factory Mutual Data Sheet 1-28 or manufacturer's data sheets. If studs are being welded to the top flanges of beams, the deck ends should be butted. If not, deck ends should be lapped. Welding washers shall be used at welded connections when deck thickness is less than 0.711 mm (0.028 inch).

Fasteners for roof insulations are specified in Section 07220, ROOF INSULATION.
****

All fasteners shall be installed in accordance with the manufacturer's recommended procedure, except as otherwise specified. The deck units shall be welded with nominal 5/8 inch diameter puddle welds [or fastened with screws, powder-actuated fasteners or pneumatically driven fasteners] to supports as indicated on the design drawings and in accordance with requirements of SDI Pub No 29. All welding of steel deck shall be in accordance with AWS D1.3 using methods and electrodes as recommended by the manufacturer of the steel deck being used. Welds shall be made only by operators previously qualified by tests prescribed in AWS D1.3 to perform the type of work required. Welding washers [shall] [shall not] be used at the connections of the deck to supports. Welding washers shall not be used at sidelaps. Holes and similar defects will not be acceptable. Deck ends shall be [lapped 2 inches] [butted]. All partial or segments of deck units shall be attached to structural supports in accordance with Section 2.5 of SDI Diaphram Mnl. [Powder-actuated fasteners shall be driven with a low-velocity piston tool by an operator authorized by the manufacturer of the piston tool. Pneumatically driven fasteners shall be driven with a low-velocity fastening tool and shall comply with the manufacturer's recommendations.] [Shear connectors shall be attached as shown and shall be welded as per AWS D1.1 [through the steel deck to the steel member] [directly to the steel member].]

3.4 HOLES AND OPENINGS

****
NOTE: When cells of cellular steel floor decking will be used for air ducts, the cutting of decking units for connections to air distribution ductwork, outlets, and system accessories must be coordinated with and specified in applicable sections of the mechanical specifications.

When cells of cellular metal floor decking will be used for electrical raceways, the inspection of these cells, cutting for inserts, and installation of electrical outlets, fittings, or grounding of the metal floor decking, be coordinated with and specified in applicable sections of the electrical specifications.
****

All holes and openings required shall be coordinated with the drawings, specifications, and other trades. Holes and openings shall be drilled or cut, reinforced and framed as indicated on the drawings or described in the specifications and as required for rigidity and load capacity. Holes and openings less than 6 inches across require no reinforcement. Holes and openings 6 to 12 inches across shall be reinforced by 0.0474 inch thick steel sheet at least 12 inches wider and longer than the opening and be fastened to the steel deck at each corner of the sheet and at a maximum of 6 inches on center. Holes and openings larger than 12 inches shall be reinforced by steel angles installed perpendicular to the steel joists and supported by the adjacent steel joists. Steel angles shall be installed perpendicular to the deck ribs and shall be fastened to the angles perpendicular to the steel joists. Openings must not interfere with seismic members such as chords and drag struts.

3.5 PREPARATION OF FIRE-PROOFED SURFACES

Deck surfaces, both composite and noncomposite, which are to receive sprayed-on fireproofing, shall be galvanized and shall be free of all grease, mill oil, paraffin, dirt, salt, and other contaminants which impair adhesion of the fireproofing. Any required cleaning shall be done prior to steel deck installation using a cleaning method that is compatible with the sprayed-on fireproofing.

-- End of Section --

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Superseding
CEGS-05500 (August 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

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07/97

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 05500

MISCELLANEOUS METAL
07/97

****
NOTE: This section covers requirements for miscellaneous metalwork for general building construction which is not part of Structural Steel or Metal Deck. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF-45 (1980; R 1993) Designation System for Aluminum Finishes

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A14.3	(1992) Ladders - Fixed - Safety Requirements
ANSI MH28.1	(1982) Design, Testing, Utilization, and Application of Industrial Grade Steel Shelving

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1996) Carbon Structural Steel
ASTM A 53	(1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 283	(1993a) Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 467	(1993) Machine and Coil Chain
ASTM A 475	(1995) Zinc-Coated Steel Wire Strand
ASTM A 500	(1993) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 653	(1996) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 924	(1996a) Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 26	(1996a) Aluminum-Alloy Sand Castings
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
ASTM B 429	(1995) Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM D 2047	(1993) Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine
ASTM F 1267	(1991) Metal, Expanded, Steel

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1995) Minimum Design Loads for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 (1994) Structural Welding Code - Steel

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-344 (Rev B) Lacquer, Clear Gloss, Exterior, Interior

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531 (1993) Metal Bar Grating Manual

NAAMM MBG 532 (1988) Heavy Duty Metal Bar Grating Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 211 (1992) Chimneys, Fireplaces, Vents and Solid Fuel-Burning Appliances

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Miscellaneous Metal Items; [_____].

Detail drawings indicating material thickness, type, grade, and class; dimensions; and construction details. Drawings shall include catalog cuts, erection details, manufacturer's descriptive data and installation instructions, and templates. Detail drawings for the following items: [_____]

SD-14 Samples

Miscellaneous Metal Items; [_____].

Samples of the following items: [_____]. Samples shall be full size, taken from manufacturer's stock, and shall be complete as required for installation in the structure. Samples may be installed in the work, provided each sample is clearly identified and its location recorded.

1.3 GENERAL REQUIREMENTS

****

NOTE: Galvanizing will be specified for items installed in exterior exposures subject to salt spray or corrosive fumes and interior areas of continual wetting or high humidity.

Designer should require materials, products, and innovative construction methods and techniques which are environmentally sensitive, take advantage of recycling and conserve natural resources.

****

The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Welding to or on structural steel shall be in accordance with AWS D1.1. Items specified to be galvanized, when practicable and not indicated otherwise, shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM A 123, ASTM A 653, or ASTM A 924, as applicable. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Joints exposed to the weather shall be formed to exclude water.

1.4 DISSIMILAR MATERIALS

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of bituminous paint or asphalt varnish.

1.5 WORKMANSHIP

Miscellaneous metalwork shall be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Welding shall be continuous along the entire area of contact except where tack welding is permitted. Exposed connections of work in place shall not be tack welded. Exposed welds shall be ground smooth. Exposed surfaces of work in place shall have a smooth finish, and unless otherwise approved, exposed riveting shall be flush. Where tight fits are required, joints shall be milled. Corner joints shall be coped or mitered, well formed, and in true alignment. Work shall be accurately set to established lines and elevations and securely fastened in place. Installation shall be in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

1.6 ANCHORAGE

Anchorage shall be provided where necessary for fastening miscellaneous metal items securely in place. Anchorage not otherwise specified or indicated shall include slotted inserts made to engage with the anchors, expansion shields, and power-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; and lag bolts and screws for wood.

1.7 ALUMINUM FINISHES

****

NOTE: Retain last bracketed sentence when aluminum surfaces need protection from plaster or concrete during construction.

****

Unless otherwise specified, aluminum items shall have [standard mill finish.] [hand sanded or machine finish to a 240 grit.] [anodized finish.] The thickness of the coating shall be not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations in AA DAF-45. Items to be anodized shall receive a polished satin finish. [Aluminum surfaces to be in contact with plaster or concrete during construction shall be protected with a field coat conforming to CID A-A-344.]

1.8 SHOP PAINTING

Surfaces of ferrous metal except galvanized surfaces, shall be cleaned and shop coated with the manufacturer's standard protective coating unless otherwise specified. Surfaces of items to be embedded in concrete shall not be painted. Items to be finish painted shall be prepared according to manufacturer's recommendations or as specified.

PART 2 PRODUCTS

2.1 ACCESS DOORS AND PANELS

****

NOTE: Access doors in fire-rated walls and ceilings will be of equivalent fire ratings. Prime coat should be specified if it is desirable to have a field painted finish.

****

Doors and panels shall be flush type unless otherwise indicated. Frames for access doors shall be fabricated of not lighter than 16 gauge steel with welded joints and finished with anchorage for securing into construction. Access doors shall be a minimum of 14 by 20 inches and of not lighter than 14 gauge steel, with stiffened edges, complete with attachments. Access doors shall be hinged to frame and provided with a flush face, screw driver operated latch. Exposed metal surfaces shall have a [baked enamel finish] [shop applied prime coat].

2.2 CHIMNEYS, VENTS, AND SMOKESTACKS

Chimneys and vents shall be designed and constructed in accordance with NFPA 211. Chimney connectors shall be formed of not lighter than 20 gauge galvanized steel. Stacks shall be designed and constructed to withstand a wind velocity of [_____] mile/h in accordance with ASCE 7. Unlined stacks shall be constructed of black-steel plates not less than 3/16 inchthick conforming to ASTM A 36. Seams and joints shall be welded, except that an angle flange shall be provided for connection to the boiler, other equipment, and stack support.

2.3 CLEANOUT DOORS

Cleanout doors shall be [galvanized] [cast iron], shall be provided with frames, and unless otherwise indicated, shall be sized to match flues. The frames shall have a continuous flange and anchors for securing into masonry. The doors shall be smokeproof, hinged, and shall have fastening devices to hold the door closed.

2.4 COAL-HOPPER DOORS

Coal-hopper doors shall be constructed of [galvanized] [_____] steel plates and shapes and shall be complete with frame, stops, wall box, hinges, and hasp or locktype latch. Joints and attachments shall be welded.

2.5 CORNER GUARDS AND SHIELDS

Corner guards and shields for jambs and sills of openings and edges of platforms shall be steel shapes and plates anchored in masonry or concrete with welded steel straps or end weld stud anchors. Corner guards for use with glazed or ceramic tile finish on walls shall be formed of 0.0625 inch thick corrosion-resisting steel with polished or satin finish, shall extend 5 feet above the top of cove base or to the top of the wainscot, whichever is less, and shall be securely anchored to the supporting wall. Corner guards on exterior shall be [galvanized] [_____].

2.6 DOOR GUARDS

Door guards shall be constructed of woven steel wire or expanded metal framed with structural steel shapes. Expanded metal guards shall be of 1-1/2 inch No. 10 mesh, welded to 1 by 1 by 1/8 inch angle frame. Woven-wire panel shall be of 10 gauge, 1-1/2 inch mesh secured through weaving to 1 inchchannel frame or around a 3/8 inch round bar frame. Corners of frames shall be mitered and welded. Guards shall be sized as indicated.

2.7 PIPE GUARDS

Pipe guards shall be heavy duty steel pipe conforming to ASTM A 53, Type E or S, weight STD, black finish.

2.8 DOWNSPOUT BOOTS

Downspout boots shall be cast iron with receiving bells sized to fit downspouts.

2.9 EXPANSION JOINT COVERS

****

NOTE: Floor expansion joint covers will be designed to support the required loads in the area and permit the calculated movement. Floor expansion joint covers will be so detailed that the top of cover plate is flush with adjoining finished floor surfaces. Plain surface floor plate will be used on interior finished floors and abrasive surface floor plate will be used on exposed concrete interior floors and exterior applications. Covers will be of

steel if deemed adequate for serviceability, and the paragraph will be modified accordingly. Expansion joints will be detailed on the contract drawings and the covers will be of equivalent fire ratings as the surrounding areas.
****

Expansion joint covers shall be constructed of extruded aluminum with anodized satin finish for walls and ceilings and with standard mill finish for floor covers and exterior covers. Plates, backup angles, expansion filler strip and anchors shall be designed as indicated. Expansion joint system shall provide a [_____] hour fire rating and [_____] inchmovement.

2.10 FIRE ESCAPES

****
NOTE: Fire escapes will be of the type, arrangement, and design to conform to fire escape stairs, Section 5-2.9 of NFPA 101.
****

Fire escapes shall be fabricated of steel shapes, shall have treads, platforms and railings as specified for steel stairs, and shall be complete with required fastenings and accessories. Fire escapes and accessories shall be [galvanized] [_____].

2.11 FLOOR GRATINGS AND FRAMES

[Carbon steel] [Aluminum] [Stainless steel] grating shall be designed in accordance with [NAAMM MBG 531] [NAAMM MBG 532] to meet the indicated load requirements. Edges shall be banded with bars 1/4 inch less in height than bearing bars for grating sizes above 3/4 inch. Banding bars shall be flush with the top of bearing grating. Frames shall be of welded steel construction finished to match the grating. Floor gratings and frames shall be [galvanized after fabrication] [_____].

2.12 FLOOR PLATES

****
NOTE: Specific pattern should not be indicated unless required for matching purposes or to meet design requirements.
****

Floor plates shall be 1/4 inch thick, [raised thread steel.] [pattern indicated.] [galvanized.] [slip-resistant, carbon steel conforming to ASTM A 283 having a minimum static coefficient of friction of 0.50 when tested in accordance with ASTM D 2047. Wearing surface shall be aluminum oxide or silicon carbide.]

2.13 FOUNDATION VENTS

Foundation vents shall be the same size as the masonry units or sized as indicated, and shall be of extruded aluminum with integral water stop and sliding interior closer or damper operable from the outside. Insect screen shall be provided at the back of the vent. Louvered opening shall have top and bottom drip lips, and the net ventilating area with closer or damper open shall be at least 35 percent of the gross wall opening. The frames shall have a structural strength adequate to permit use in masonry walls without a lintel.

2.14 HANDRAILS

****

NOTE: Handrails specified are the utilitarian type. Drawings will show design requirements, location, and general configuration of railing.

****

Handrails shall be designed to resist a concentrated load of 200 pounds in any direction at any point of the top of the rail or 20 pounds per foot applied horizontally to top of the rail, whichever is more severe.

2.14.1 Steel Handrails, Including Carbon Steel Inserts

Steel handrails, including inserts in concrete, shall be [steel pipe conforming to ASTM A 53] [or] [structural tubing conforming to ASTM A 500, Grade A or B of equivalent strength]. Steel railings shall be [1-1/2] [2] inch nominal size. Railings shall be [hot-dip galvanized] [and] [shop painted]. Pipe collars shall be [steel.] [hot-dip galvanized steel.] [stainless steel.]

a. Joint posts, rail, and corners shall be fabricated by one of the following methods:

(1) Flush type rail fittings of commercial standard, welded and ground smooth with railing splice locks secured with 3/8 inch hexagonal recessed-head setscrews.

(2) Mitered and welded joints by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints, and grinding smooth. Railing splices shall be butted and reinforced by a tight fitting interior sleeve not less than 6 inches long.

(3) Railings may be bent at corners in lieu of jointing, provided bends are made in suitable jigs and the pipe is not crushed.

b. Removable sections, toe-boards, and brackets shall be provided as indicated.

2.14.2 Aluminum Handrails

Handrails shall consist of [[1-1/2] [2] inch nominal Schedule 40 pipe ASTM B 429] [1-3/4 inch square aluminum semi-hollow tube with rounded corners ASTM B 221]. Railings and pipe collars shall be [mill finish] [anodized] [aluminum [_____] color]. All fasteners shall be Series 300 stainless steel.

a. Jointing shall be by one of the following methods:

(1) Flush type rail fittings, welded and ground smooth with splice locks secured with 3/8 inch recessed head setscrews.

(2) Mitered and welded joints, made by fitting post to top rail and intermediate rail to post and corners, shall be groove welded

and ground smooth. Splices, where allowed by the Contracting Officer, shall be butted and reinforced by a tight fitting dowel or sleeve not less than 6 inches in length. Dowel or sleeve shall be connected to one side of the splice by tack welding or by using epoxy cement.

(3) Railings shall be assembled using slip-on aluminum-magnesium alloy fittings for joints. Fittings shall be fastened to pipe or tube with 1/4 inch or 3/8 inch stainless steel recessed head setscrews. Assembled railings shall be provided with fittings only at vertical supports or at rail terminations attached to walls. Expansion joints shall be at the midpoint of panels. A setscrew shall be provided in only one side of the slip-on sleeve. Alloy fittings shall conform to ASTM B 26.

b. Removable sections, toe-boards and brackets shall be provided where indicated, using flange castings as appropriate.

2.15 GUY CABLES

Guy cables shall be prestretched, galvanized wire rope of the sizes indicated. Wire rope shall conform to ASTM A 475, high strength grade with Class A coating. Guys shall have a factory attached clevis top-end fitting; guys shall have a factory attached open-bridge strand socket bottom-end fitting; guys shall be complete with oval eye, threaded anchor rods. Fittings and accessories shall be hot-dip galvanized.

2.16 LADDERS

Ladders shall be [galvanized] [_____] steel or aluminum, fixed rail type in accordance with ANSI A14.3.

2.17 METAL GRID WALKWAYS

****

NOTE: Walkways must be designed to allow roof movements and to resist wind forces and creep. At building expansion joints a bridge piece should be installed. Supports must be sized to distribute the walkway loads to the roof material.

****

Metal grid walkways shall be designed to protect rooftops from pedestrian traffic and shall be [14 gauge minimum galvanized steel] [12 gauge minimum aluminum]. The walkway shall consist of metal planks, 2 by 10 or 12 feet, bolted or welded to support stands. Other sizes may be furnished if approved. In addition to end supports, a midspan support shall be provided when required to limit deflection. End supports shall be located to avoid uplift and to provide continuous runs.

2.18 MIRROR FRAMES

Frames for plate glass mirrors larger than 18 by 30 inches shall be fabricated from [extruded aluminum with anodized finish.] [corrosion-resisting steel with satin finish.] Frames shall be provided with concealed fittings and tamperproof mountings.

2.19 MISCELLANEOUS

****
NOTE: Construction details should be indicated on the drawings for clarification of the type and the arrangement of miscellaneous metal.
****

Miscellaneous plates and shapes for items that do not form a part of the structural steel framework, such as lintels, sill angles, miscellaneous mountings, and frames, shall be provided to complete the work.

2.20 PARTITIONS, DIAMOND MESH TYPE

****
NOTE: Partition details should be indicated and where required for security reasons should extend to underside of floor or roof above.
****

Partitions shall be constructed of metal fabric attached to structural steel framing members. Fabric shall be [10 gauge steel wires woven into 1-1/2 inch diamond mesh with wire secured through weaving channels.] [expanded metal conforming to ASTM F 1267 of 1-1/2 inch, No. 10 diamond mesh secured to channel frame by welding.] [8 gauge steel wires woven into 2 inch diamond mesh with wire secured through weaving channels.] Framing members shall be channels 1-1/2 by 1/8 inch minimum size. Channel frames shall be mortised and tenoned at intersections. Steel frames, posts, and intermediate members shall be of the sizes and shapes indicated. Cast-iron floor shoes and caps shall have setscrew adjustment. Doors and grilles shall be provided as indicated, complete with hardware and accessories including sliding mechanisms, locks, guard plates, sill shelves and brackets, and fixed pin butts. Doors and grilles shall have cover plates as indicated. Dutch doors shall have a lock for each leaf. A continuous rubber bumper shall be provided at bottom of grille frame. Locks shall be bronze, cylinder, mortise type. Keying shall be coordinated with Section 08700 BUILDERS' HARDWARE. Ferrous metal portions of partitions and accessories shall be [galvanized] [_____].

2.21 ROLL-UP FLOOR MATS

****
NOTE: Entrance roll-up mats trap dirt and mud thereby reducing building maintenance. Mats will only be used in interior of buildings at major entrances when required. Designers should review commercial products and specify selection.
****

Roll-up mats shall be of aluminum construction with [carpet] [vinyl] [serrated aluminum] [abrasive] surface. Roll-up mats shall be for use in [level surface area.] [recessed area. Construction details of recessed areas shall be shown on the drawings.]

2.22 ROOF SCUTTLES

Roof scuttles shall be of [aluminum] [galvanized steel not less than 14 gauge,] with 3 inch beaded flange welded and ground at corners. Scuttle shall be sized to provide minimum clear opening of 37 by 30 inches. Cover and curb shall be insulated with 1 inch thick rigid insulation covered and protected by [aluminum sheet] [galvanized steel liner not less than 26 gauge.] The curb shall be equipped with an integral metal cap flashing of the same gauge and metal as the curb, full welded and ground at corners for weathertightness. Scuttle shall be completely assembled with heavy hinges, compression spring operators enclosed in telescopic tubes, positive snap latch with turn handles on [inside] [and] [outside] and neoprene draft seal. Fasteners shall be provided for padlocking on the inside. The cover shall be equipped with an automatic hold-open arm complete with handle to permit one hand release.

2.23 SAFETY CHAINS

Safety chains shall be galvanized welded steel, proof coil chain tested in accordance with ASTM A 467, Class CS. Safety chains shall be straight link style, 3/16 inch diameter, minimum 12 links per foot and with bolt type snap hooks on each end. Eye bolts for attachment of chains shall be galvanized 3/8 inch bolt with 3/4 inch eye, anchored as indicated. Two chains shall be furnished for each guarded opening.

2.24 SAFETY NOSING

Safety nosings shall be of [cast iron] [cast aluminum] with [cross-hatched] [plain], abrasive surface. Nosing shall be 3 inches wide and terminating at not more than 6 inches from the ends of treads, except nosing for metal pan cement-filled treads shall extend the full length of the tread. Safety nosings shall be provided with anchors not less than 3/4 inch long. Integrally cast mushroom anchors are not acceptable.

2.25 SHELVING

Shelving shall conform to ANSI MH28.1 and shall be [bolted] [clipped] [open] [closed] and capable of resisting a uniform load of [_____] lbs per foot. Minimum dimensions and number of shelves shall be as indicated.

2.26 STEEL STAIRS

Steel stairs shall be complete with structural or formed channel stringers, [steel plate treads and risers,] [metal pan cement-filled treads,] [grating treads,] [slip-resistant metallic treads,] landings, columns, handrails, and necessary bolts and other fastenings as indicated. Structural steel shall conform to ASTM A 36. Stairs and accessories shall be [galvanized] [_____]. Risers on stairs with metal pan treads shall be deformed to form a sanitary cove to retain the tread concrete. Integral nosings shall have braces extended into the concrete fill. Gratings for treads and landings shall conform to NAAMM MBG 531. Grating treads shall have slip-resistant nosings.

2.27 STEEL DOOR FRAMES

Steel door frames built from structural shapes shall be neatly mitered and securely welded at the corners with all welds ground smooth. Jambs shall be provided with 2 by 1/4 by 12 inch bent, adjustable metal anchors spaced not over 2 feet 6 inches on centers. Provision shall be made to stiffen the top member for all spans over 3 feet. Continuous door stops shall be made of 1-1/2 by 5/8 inch bars.

2.28 TRENCH COVERS, FRAMES, AND LINERS

Trench covers shall be designed to meet the indicated load requirements.

Trench frames and anchors shall be all welded steel construction designed to match cover. Covers shall [be secured to frame] [have flush drop handles formed of 1/4 inch round stock], and shall be [raised-tread, or steel floor plate] [cast-iron grating]. Grating opening widths shall not exceed 1 inch. Trench liners shall be cast iron with integral frame for cover.

2.29 WHEELGUARDS

Wheelguards shall be hollow, heavy duty, cast iron [half round] [three quarters round], at least 18 inches high designed to provide a minimum of 6 inches of protection.

2.30 WINDOW GUARDS, BAR GRILLE TYPE

Bar grill window guards shall be of 3/4 inch round bars, spaced not over 4 inches on centers vertically, and 2 by 1/2 inch horizontal bars spaced not over 12 inches on centers. Vertical bars shall be extended through and securely welded to the cross bars. Horizontal bars shall be extended, bent, and drilled as shown for anchorage at jambs of window openings.

2.31 WINDOW GUARDS, DIAMOND MESH TYPE

Diamond mesh window guards shall be constructed of woven steel wire or expanded metal frames with hot-rolled or cold-formed steel shapes. Expanded metal conforming to ASTM F 1267 shall be of 1-1/2 inch, No. 10 mesh, welded to 1 by 1 by 1/8 inchangle frame. Woven-wire panels shall be of 10 gauge, 1-1/2 inch mesh secured through weaving bar to 3/8 inch round or 1 inch channel frame. Corners of frames shall be mitered and welded or mortised and tenoned. One tamperproof hasp and padlock, with access from the interior, shall be provided for each butt used.

2.32 WINDOW SUB-SILL

Window sub-sill shall be of extruded aluminum alloy of size and design indicated. Not less than two anchors per window section shall be provided for securing into mortar joints of masonry sill course. Sills for banks of windows shall have standard mill finish with a protective coating, prior to shipment, of two coats of a clear, colorless, methacrylate lacquer applied to all surfaces of the sills.

2.33 WINDOW WELLS

Window wells shall be not lighter than 16 gauge,corrugated sheet steel, hot-dip galvanized after fabrication. Top edge of walls shall have a 3/4 inch bead or rolled top. Window wells shall be semicircular or semielliptical in form and shall overlap the window by at least 3 inches on each side. Removable cover, hot-dip galvanized after fabrication, consisting of steel bar grate with bars spaced at not more than 2 inch centers and welded to 1 by 1/4 inch frame shall be designed to fit into and rest on top edge of window well.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

All items shall be installed at the locations shown and according to the manufacturer's recommendations. Items listed below require additional procedures as specified.

3.2 REMOVABLE ACCESS PANELS

A removable access panel not less than 12 by 12 inches shall be installed directly below each valve, flow indicator, damper, or air splitter that is located above the ceiling, other than an acoustical ceiling, and that would otherwise not be accessible.

3.3 INSTALLATION OF CHIMNEYS, VENTS, AND SMOKESTACKS

Chimneys and vents shall be installed in accordance with NFPA 211. A cleanout opening with a tight-fitting, hinged, cast-iron door and frame shall be provided at the base of each smokestack. A top band shall be provided on stacks for attachment of painter's rigging. Roof housing, rain cap, downdraft diverter, fire damper, and other accessories required for a complete installation shall be provided. Sections of prefabricated lined stacks shall be joined with acid-resisting high-temperature cement and steel draw bands. Means to prevent accumulation of water in the smokestack shall be provided.

3.4 DOOR GUARD FRAME

Door guard frame shall be mounted over the glazed opening using 1/4 inch lag bolts on the interior of wood doors or tamperproof through bolts on the interior of metal doors.

3.5 INSTALLATION OF PIPE GUARDS

****

NOTE: Details of pipe guard installation will be shown on the drawings.

****

Pipe guards shall be set vertically in concrete piers. Piers shall be constructed of, and the hollow cores of the pipe filled with, concrete [specified in SECTION 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.] [having a compressive strength of 3000 psi.]

3.6 INSTALLATION OF DOWNSPOUT BOOTS

Downspouts shall be secured to building through integral lips with appropriate fasteners.

3.7 ATTACHMENT OF HANDRAILS

Toeboards and brackets shall be installed where indicated. Splices, where required, shall be made at expansion joints. Removable sections shall be installed as indicated.

3.7.1 Installation of Steel Handrails

Installation shall be [in pipe sleeves embedded in concrete and filled with molten lead or sulphur with anchorage covered with standard pipe collar pinned to post.] [by means of pipe sleeves secured to [wood with screws.] [masonry with expansion shields and bolts or toggle bolts.] [base plates bolted to stringers or structural steel framework.]] Rail ends shall be secured by steel pipe flanges [anchored by expansion shields and bolts.] [through-bolted to a back plate or by 1/4 inch lag bolts to studs or solid backing.]

3.7.2 Installation of Aluminum Handrails

Installation shall be by means of [flanges anchored to concrete or masonry by expansion shields] [base plates or flanges bolted to stringers or structural steel framework] [flanges through-bolted to a back plate or by 1/4 inch lag bolts to studs or other structural members]. Bolts used to anchor aluminum alloy flanges shall be stainless steel of a size appropriate to the standard product of the manufacturer. Where aluminum or alloy fittings or extrusions are to be in contact with dissimilar metals or portland cement concrete, the contact surface shall be given a heavy coating of bituminous paint or asphalt varnish.

3.8 ERECTION OF GUY CABLES

Guy cables shall be erected as indicated. Anchor rods shall be cast in concrete located and reinforced as shown.

3.9 INSTALLATION OF METAL GRID WALKWAYS

Walkways shall be installed after final flood coat and aggregate surfacing. Each stand shall be set on a protective pad; the pad may be adhesively attached to the bottom of the stand or set loose under the stand. The area where the supports are to be located shall be swept clear of loose aggregate. Protective pad shall be placed on the roof membrane except on inverted roofs where the protective pad shall be set on the rigid insulation.

3.10 PARTITION POSTS AND OPENINGS

Posts shall be set in shoes bolted to the floor and in caps tap-screwed to clip angles in overhead construction, as indicated. Openings shall be formed using channels similar to the partition frames at ducts, pipes, and other obstructions.

3.11 RECESSED FLOOR MATS

Contractor shall verify field measurements prior to releasing materials for fabrication by the manufacturer. A mat frame shall be used to ensure recess accuracy in size, shape and depth. Drain pit shall be formed by blocking out concrete when frames are installed. Pit shall be dampproofed after concrete has set. Frames shall be assembled onsite and installed so that upper edge will be level with finished floor surface. A cement base shall be screeded inside the mat recess frame area using the edge provided by the frame as a guide. The frame shall be anchored into the cement with anchor pins a minimum of 24 inches on centers.

3.12 MOUNTING OF SAFETY CHAINS

Safety chains shall be mounted 3 feet 6 inches and 2 feet above the floor.

3.13 INSTALLATION OF SAFETY NOSINGS

Nosing shall be completely embedded in concrete before the initial set of the concrete occurs and shall finish flush with the top of the concrete surface.

3.14 DOOR FRAMES

Door frames shall be secured to the floor slab by means of angle clips and expansion bolts. Continuous door stops shall be welded to the frame or tap screwed with countersunk screws at no more than 18 inchcenters, assuring in either case full contact with the frame. Any necessary reinforcements shall be made and the frames shall be drilled and tapped as required for hardware.

3.15 TRENCH FRAMES AND COVERS

Trench frames and covers shall finish flush with the floor.

3.16 INSTALLATION OF WHEEL GUARDS

Wheel guards shall be filled with concrete and anchored to the floor or the building according to the manufacturer's recommendations.

3.17 BAR-GRILLE WINDOW GUARDS

Bar-grille window guards shall be securely anchored to masonry with 1/2 inch diameter prison-type screws or bolts and expansion shields, or other type of fastenings if the ends of such fastenings are welded to the adjoining metal grilles or otherwise made tamperproof in a satisfactory manner. Spanner-head screws or bolts are not considered prison-type fasteners.

3.18 DIAMOND MESH WINDOW GUARDS

Diamond mesh window guards shall be mounted on [interior window frame with not less than two tamperproof hinged butts mounted on wood jambs.] [exterior of window frame with not less than two tamperproof hinged butts mounted on 1 by 12 by 1/8 inch jamb channel attached as indicated to 2 by 1/4 inch plate anchored to wood jamb with 1/4 inch lag bolt, to masonry jamb with toggle bolts, or to concrete jambs and solid masonry jambs with expansion shields and bolts.] One additional butt shall be provided for each 3 foot internal length of guard over 5 feet. Hasp and padlock shall be installed on the jamb opposite to that hinged.

3.19 INSTALLATION OF WINDOW WELLS

Window wells shall be placed as shown with the walls securely anchored to foundation surface. The area within the well shall be excavated to the bottom of the well and covered with a 4 inch thick layer of coarse gravel or crushed rock.

-- End of Section --

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS

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SECTION 06100

ROUGH CARPENTRY
09/96

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NOTE: This guide specification covers the requirements for rough carpentry. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for fire-retardant treatment, structural wood, sheathing, subflooring, underlayment, shear wall panels, roof decking, and insulation. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****

NOTE: Designer should require materials, products, and innovative construction methods and techniques which are environmentally sensitive, take advantage of recycling and conserve natural resources.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN FOREST & PAPER ASSOCIATION (AF&PA)

AF&PA T01 (1991; Supple 1993; Addenda Apr 951997; Supple T02) National Design Specification for Wood Construction

AF&PA T11 (1988) Manual for Wood Frame Construction

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4 (1995) Basic Hardboard

AHA A194.1 (1985) Cellulosic Fiber Board

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

AITC TC Manual (1994) Timber Construction Manual

AITC 109 (1990) Standard for Preservative Treatment of Structural Glued Laminated Timber

AITC 111 (1979) Recommended Practice for Protection of Structural Glued Laminated Timber During Transit, Storage and Erection

AITC 190.1 (1992) Wood Products - Structural Glued Laminated Timber

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A208.1(1999) Particleboard Mat Formed Woods

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 307 (1997) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

ASTM C 79/C 79M (1997) Treated Core and Nontreated Core Gypsum Sheathing Board

ASTM C 208	(1995) Cellulosic Fiber Insulating Board
ASTM C 516	(1980; R 1996) Vermiculite Loose Fill Thermal Insulation
ASTM C 518	(1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties By Means of the Heat Flow Meter Apparatus
ASTM C 549	(1981; R 1995) Perlite Loose Fill Insulation
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 553	(1992) Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation
ASTM C 665	(1998) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C 726	(1993) Mineral Fiber Roof Insulation Board
ASTM C 739	(1997) Cellulosic Fiber (Wood-Base) Loose-Fill Thermal Insulation
ASTM C 764	(1994) Mineral Fiber Loose-Fill Thermal Insulation
ASTM C 1136	(1995) Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C 1177/C 1177M	(1996) Glass Mat Gypsum Substrate for Use as Sheathing
ASTM C 1289	(1998) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D 2898	(1996) Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
ASTM D 3498	(1993) Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems
ASTM E 84	(1998el) Surface Burning Characteristics of Building Materials

ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM E 154	(1996) Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
ASTM F 547	(1977; R 1990) Definitions of Terms Relating to Nails for Use with Wood and Wood-Base Materials

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C2	(1995) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
AWPA C9	(1997) Plywood - Preservative Treatment by Pressure Processes
AWPA C20	(1996) Structural Lumber Fire-Retardant Pressure Treatment
AWPA C27	(1996) Plywood - Fire-Retardant Pressure Treatment
AWPA M4	(1996) Standard for the Care of Preservative-Treated Wood Products
AWPA P5	(1997) Standards for Waterborne Preservatives

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA EWS R540C	(1996) Builder Tips Proper Storage and Handling of Glulam Beams
APA EWS T300C	(1997) Glulam Connection Details
APA PRP-108	(1994; Rev 1997) Performance Standards and Policies for Structural-Use Panels (Form No. E445Q)

CALIFORNIA REDWOOD ASSOCIATION (CRA)

CRA RIS-01-SS	(1997) Standard Specifications for Grades of California Redwood Lumber

CODE OF FEDERAL REGULATIONS (CFR)

16 CFR 1209	Interim Safety Standard for Cellulose Insulation

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1	(1996) Voluntary Product Standard - Construction and Industrial Plywood
DOC PS 2	(1992) Performance Standards for

Wood-Based Structural-Use Panels

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM LPD 1-49	(1995) Loss Prevention Data Sheet - Perimeter Flashing

NATIONAL HARDWOOD LUMBER ASSOCIATION (NHLA)

NHLA Rules	(1994) Rules for the Measurement & Inspection of Hardwood & Cypress

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

NELMA Grading Rules	(1997) Standard Grading Rules for Northeastern Lumber

SOUTHERN CYPRESS MANUFACTURERS ASSOCIATION (SCMA)

SCMA Specs	(1986; Supple No. 1, Aug 1993) Standard Specifications for Grades of Southern Cypress

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB Rules	(1994; Supple 8 thru 11) Standard Grading Rules for Southern Pine Lumber

TRUSS PLATE INSTITUTE (TPI)

TPI 1	(1995) National Design Standard for Metal Plate-Connected Wood Truss Construction and Commentary and Appendices to TPI 1
TPI Bklet HIB	(1991) Handling, Installing & Bracing Metal Plate Connected Wood Trusses

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB Std 17	(1996; Supples VII(A-E), VIII(A-C)) Grading Rules for West Coast Lumber

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA Grading Rules	(1995; Supple Nos. 1 thru 5) Western Lumber Grading Rules 95

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for

information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Structural Wood Members; [_____].

Design analysis and calculations of structural laminated members, fabricated wood trusses, and other fabricated structural members showing design criteria used to accomplish the applicable analysis.

Product Installations; [_____].

List containing name and location of successful installation of similar type of fabricated structural members specified herein.

SD-04 Drawings

Structural Wood Members; [_____]. Installation of Framing; [_____].

Drawings of structural laminated members, fabricated wood trusses, engineered wood joists and rafters, and other fabricated structural members indicating materials, shop fabrication, and field erection details; including methods of fastening.

Nailers and Nailing Strips; [_____].

Drawings of field erection details, including materials and methods of fastening nailers in conformance with Factory Mutual wind uplift rated systems specified in other Sections of these specifications.

SD-13 Certificates

Grading and Marking; [_____].

Manufacturer's certificates (approved by an American Lumber Standards approved agency) attesting that lumber and material not normally grade marked meet the specified requirements. Certificate of Inspection for grade marked material by an American Lumber Standards Committee (ALSC) recognized inspection agency prior to shipment.

Insulation; [_____].

Certificate attesting that the cellulose, perlite, glass and mineral fiber,glass mat gypsum roof board, polyurethane, or polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

1.3 DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition, stored off ground in fully covered, well ventilated areas, and protected from extreme changes in temperature and humidity. Laminated timber shall be handled and stored in accordance with AITC 111 or APA EWS R540C.

PART 2 PRODUCTS

2.1 LUMBER AND SHEATHING

2.1.1 Grading and Marking

2.1.1.1 Lumber Products

Solid sawn and finger-jointed lumber shall bear an authorized gradestamp or grademark recognized by ALSC, or an ALSC recognized certification stamp, mark, or hammerbrand. Surfaces that are to be exposed to view shall not bear grademarks, stamps, or any type of identifying mark. Hammer marking will be permitted on timbers when all surfaces will be exposed to view.

2.1.1.2 Fabricated Structural Members

Wood trusses shall be fabricated in accordance with TPI 1. Laminated timbers shall be marked with a quality mark indicating conformance to AITC 190.1. Engineered wood joists and rafters shall be fabricated using an approved quality control system to meet specified requirements.

2.1.1.3 Plywood and Other Sheathing Products

Materials shall bear the grademark or other identifying marks indicating grades of material and rules or standards under which produced, including requirements for qualifications and authority of the inspection organization. Except for plywood and wood structural panels, bundle marking will be permitted in lieu of marking each individual piece. Surfaces that are to be exposed to view shall not bear grademarks or other types of identifying marks.

2.1.2 Sizes

Lumber and material sizes shall conform to requirements of the rules or standards under which produced. Unless otherwise specified, lumber shall be surfaced on four sides. Unless otherwise specified, sizes indicated are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.

2.1.3 Treatment

Exposed areas of treated wood that are cut or drilled after treatment shall receive a field treatment in accordance with AWPA M4. Items of all-heart material of cedar, cypress, or redwood will not require preservative treatment, except when in direct contact with soil. Except as specified for all-heart material of the previously mentioned species, the following items shall be treated:

a. Wood members in contact with or within 18 inches of soil.

b. Wood members in contact with water.

c. Wood members exposed to the weather including those used in builtup roofing systems or as nailing strips or nailers over fiberboard or gypsum-board wall sheathing as a base for wood siding.

d. Wood members set into concrete regardless of location, including flush-with-deck wood nailers for roofs.

e. Wood members in contact with concrete that is in contact with soil or water or that is exposed to weather.

2.1.3.1 Lumber and Timbers

Lumber and timbers shall be treated in accordance with AWPA C2 with waterborne preservatives listed in AWPA P5 to a retention level as follows:

a. 0.25 pcf intended for above ground use.

b. 0.40 pcf intended for ground contact and fresh water use.

2.1.3.2 Plywood

Plywood shall be treated in accordance with AWPA C9 with waterborne preservatives listed in AWPA P5 to a retention level as follows:

a. 0.25 pcf intended for above ground use.

b. 0.40 pcf intended for ground contact and fresh water use.

2.1.4 Moisture Content

At the time lumber and other materials are delivered and when installed in the work their moisture content shall be as follows:

a. Treated and Untreated Lumber Except Roof Planking: 4 inches or less, nominal thickness, 19 percent maximum. 5 inches or more, nominal thickness, 23 percent maximum in a 3 inch perimeter of the timber cross-section.

b. Roof Planking: 15 percent maximum.

c. Materials Other Than Lumber: In accordance with standard under which product is produced.

2.1.5 Fire-Retardant Treatment

****

NOTE: List items to be treated. Fire-retardant treatment will be specified for exposed plywood and exposed wood structural members when a flame spread rating of 25 or less is required. In addition, exterior grade fire-retardant treatment will be required for exposed wood structural members located where the relative humidity may be 80 percent or more.

Fire-retardant treated plywood will be used only for nonstructural applications which are not subject to elevated temperature or high humidity. Fire-retardant treated plywood will not be used in any part of the roof or roofing system.

Consult AWPA C20 and AWPA C27 for material selection and use.

****

Fire-retardant treated wood shall be pressure treated in accordance with AWPA C20 for lumber and AWPA C27 for plywood. Material use shall be defined in AWPA C20 and AWPA C27 for Interior Type [A] [and] [B] and Exterior Type. Treatment and performance inspection shall be by an independent and qualified testing agency that establishes performance ratings. Each piece or bundle of treated material shall bear identification of the testing agency to indicate performance in accordance with such rating. Treated materials to be exposed to rain wetting shall be subjected to an accelerated weathering technique in accordance with ASTM D 2898 prior to being tested for compliance with AWPA C20 or AWPA C27. Items to be treated include: [_____].

2.1.6 Structural Wood Members

****

NOTE: Show stress diagrams for framing system and minimum stress values on contract drawings. Design values for structural lumber used in fabrication of bolted trusses and other fabricated structural members for engineered uses, except laminated members, will be computed in accordance with AF&PA T01. Allowable unit stresses will be specified and will not be less than 7.2 MPa (1050 psi) in bending for single member use; 8.3 MPa (1200 psi) in bending for repetitive member use; 4.8 MPa (700 psi) in tension; 2.1 MPa (300 psi) in compression perpendicular to the grain; 2.1 MPa (300 psi) in compression parallel to the grain; and 0.4 MPa (60 psi) in horizontal shear with modulus of elasticity of 8275 MPa (1,200,000 psi).

****

Species and grades shall be as listed in AF&PA T01. Structural lumber used in fabrication of bolted trusses and other fabricated structural members for engineered uses, except laminated members, shall have allowable design values of [_____] psi in bending; [_____] psi in tension parallel to the grain; [_____] psi in compression perpendicular to the grain; [_____] psi in compression parallel to the grain; [_____] psi in horizontal shear; and a modulus of elasticity of [_____] psi. Joists, rafters including trussed type, decking, and headers shall have design values of [_____] psi in bending for repetitive member uses. Design of members and fastenings shall conform to AITC TC Manual. Other stress graded or dimensioned items such as blocking, carriages, and studs shall be standard or No. 2 grade except that studs may be Stud grade.

2.1.6.1 Trussed Rafters

As an option to standard rafters, trussed rafters may be provided. The design shall be as indicated. Connections shall be made with light-metal plate-connectors. Light-metal-plate-connected wood trusses shall be designed and fabricated in conformance with TPI 1. When new plate configuration is proposed, load testing of trusses is required and shall conform to Appendix D of TPI 1.

2.1.6.2 Structural Glued Laminated Members

****

NOTE: Species and appearance grade of lumber in glued laminated members will be specified when required by aesthetic considerations. Insert stress requirements necessary. Individual wrapping will be specified when protection during erection is necessary in accordance with AITC 111 or APA EWS R540C. Preservative treatment in lieu of sealing will be specified for exposure conditions named in AITC 109 or APA EWS S580.

****

Members shall conform to AITC 190.1 with allowable design values of [_____] psi in bending; [_____] psi in tension parallel to grain; [_____] psi in compression parallel to grain; [_____] psi in compression perpendicular to grain (top); [_____] psi in compression perpendicular to grain (bottom); [_____] psi in horizontal shear; and [_____] psi in modulus of elasticity, based on dry condition. Adhesives used in fabrication shall meet the requirements of dry use service. Members shall be [industrial appearance grade] [architectural appearance grade], [sealed with a penetrating sealer] [treated with preservative], and [individually wrapped] [bundle wrapped]. Preservative treatment shall be [_____] and the retention shall be [_____] pcf in accordance with AITC 109. Members shall be complete with hardware for joining laminated members and for their connection to other construction.

2.1.6.3 Engineered Wood Joists and Rafters

As an option to standard rafters, engineered wood joists and rafters may be provided. Engineered wood rafters shall be wood I-joists manufactured in accordance with a nationally recognized code and installed in accordance with the manufacturer's recommendations.

2.1.7 Sheathing

****

NOTE: Design of plywood and wood structural panel diaphragms will be in accordance with APA L350 Design/Construction Guide, Diaphragms and Shearwalls (1997).

****

Sheathing shall be fiberboard, gypsum board, plywood, wood structural panels, or wood for wall sheathing; and plywood, wood structural panels, or wood for roof sheathing.

2.1.7.1 Fiberboard

Fiberboard shall conform to ASTM C 208, Type IV, Grade 2, Structural Grade, or AHA A194.1, Type IV, Grade 2 asphalt impregnated or asphalt coated to be water-resistant but vapor permeable.

2.1.7.2 Gypsum Sheathing Board

Glass mat gypsum sheathing shall conform to ASTM C 79/C 79M and ASTM C 1177. Gypsum board shall conform to ASTM C 79/C 79M], 1/2 inch thick, 4 feet wide with straight edges for supports 16 inches on center without corner bracing of framing or for supports 24 inches on center with corner bracing of framing; 2 feet wide with V-tongue and groove edges for supports 16 or

24 inches on center with corner bracing of framing.

2.1.7.3 Plywood

Plywood shall conform to DOC PS 1, APA PRP-108 or DOC PS 2, Grade C-D or sheathing grade with exterior glue. Sheathing for roof and walls without corner bracing of framing shall have a span rating of 16/0 or greater for supports 16 inches on center and a span rating of 24/0 or greater for supports 24 inches on center.

2.1.7.4 Wood Structural Panels

Panels shall meet the qualification requirements of APA PRP-108 or DOC PS 2 for rated sheathing, Exposure 1 or Structural I rated sheathing, Exposure 1. Sheathing for roofs or walls without corner bracing of framing shall have a span rating of 16/0 or greater for supports 16 inches on center and shall have a span rating of 24/0 or greater for supports 24 inches on center.

2.1.7.5 Wood

Species and grade shall be in accordance with TABLE I at the end of this section. Wall sheathing shall be 1 inch thick for supports 16 or 24 inches on center without corner bracing of framing provided sheathing is applied diagonally. Roof sheathing shall be 1 inch thick for supports 16 or 24 inches on center.

2.1.8 Subflooring

2.1.8.1 Plywood

Plywood shall conform to DOC PS 1, APA PRP-108 or DOC PS 2; Grade C-D or Sheathing grade with exterior glue for uses not otherwise specified; Grade C-D or sheathing grade with exterior glue for reception of underlayment or wood flooring; underlayment grade with exterior glue, or C-C (plugged) exterior grade for use as a combination subfloor-underlayment under resilient flooring. Minimum span rating for subflooring shall be 24/16 for supports 16 inches on center, and 48/24 for supports 24 inches on center. Minimum span rating for combination subfloor-underlayment shall be 16/O for supports 16 inches on center and 24/O for supports at 24 inches on center.

2.1.8.2 Wood Structural Panels

Rated wood structural panels shall be qualified for subflooring or combination subfloor-underlayment under APA PRP-108 or DOC PS 2. Subflooring shall be rated sheathing with a span rating of 24/16 or greater for supports 16 inches on center and shall have span rating of 48/24 or greater for supports 24 inches on center. Combination subfloor-underlayment shall have a span rating of 16/O or greater for supports 16 inches on center and shall have span rating for 24/O or greater for supports 24 inches on center.

2.1.8.3 Wood

Species and grade shall be in accordance with TABLE I at the end of this section, 1 inch thick, center-matched, shiplapped, or square edge.

2.1.9 Underlayment

****
NOTE: Underlayment will be limited to plywood in areas of high moisture or occasional wetting of the finished floor.
****

Underlayment shall conform to one of the following:

2.1.9.1 Hardboard

AHA A135.4 service class, sanded one side, 1/4 inch thick, 4 feet wide.

2.1.9.2 Particleboard

ANSI A208.1, Grade 1-M-1, 1/4 inch thick, 4 x 4 feet.

2.1.9.3 Plywood

Plywood shall conform to DOC PS 1, underlayment grade with exterior glue, or C-C (Plugged) exterior grade 11/32 inch thick, 4 feet wide.

2.1.10 Shear Wall Panels

Panels used in shear wall construction shall be of the span rating and thickness shown and shall be plywood conforming to DOC PS 1 or DOC PS 2, [Grade C-D with exterior glue] [Grade C-D, Structural I]; or wood structural panels conforming to APA PRP-108 or DOC PS 2, [rated sheathing, Exposure I] [Structural I rated sheathing, Exposure 1].

2.1.11 Roof Decking

****
NOTE: Delete this paragraph if the design does not include exposed decking. Commercial grade decking with minimum design value of 7.6 MPa (1100 psi) in bending will normally be used unless higher strength is required. If a specific species is required for architectural purpose, the paragraph or drawings should reflect such a requirement.
****

Roof decking shall be [commercial] [select] grade with minimum design value of [130] [1100] psi in bending. Decking shall be [2 inches thick with single tongue and groove] [4 inches thick with double tongue and groove]; V-jointed, matched and dressed. As an option, fabricated laminated lumber decking with interlocking tongue and groove joints may be provided.

2.1.12 Miscellaneous Wood Members

2.1.12.1 Nonstress Graded Members

Members shall include bridging, corner bracing, furring, grounds, and nailing strips. Members shall be in accordance with TABLE I for the species used. Sizes shall be as follows unless otherwise shown:

Member	Size (inch)
Bridging	1 x 3 or 1 x 4 for use between members 2 x 12 and smaller; 2 x 4 for use between members larger than 2 x 12.
Corner bracing	1 x 4.
Furring	1 x [2] [3].
Grounds	Plaster thickness by 1-1/2.
Nailing strips	1 x 3 or 1 x 4 when used as shingle base or interior finish, otherwise 2 inch stock.

2.1.12.2 Wood Bumpers

Bumpers shall be of the species and grade in accordance with TABLE II at the end of this section, size as shown.

2.1.12.3 Sill Plates

Sill plates shall be standard or number 2 grade.

2.1.12.4 Blocking

Blocking shall be standard or number 2 grade.

2.1.12.5 Rough Bucks and Frames

Rough bucks and frames shall be straight standard or number 2 grade.

2.2 ACCESSORIES AND NAILS

Markings shall identify both the strength grade and the manufacturer. Accessories and nails shall conform to the following:

2.2.1 Anchor Bolts

ASTM A 307, size as indicated, complete with nuts and washers.

2.2.2 Bolts: Lag, Toggle, and Miscellaneous Bolts and Screws

Type, size, and finish best suited for intended use. Finish options include zinc compounds, cadmium, and aluminum paint impregnated finishes.

2.2.3 Clip Angles

Steel, 3/16 inch thick, size best suited for intended use; or zinc-coated steel or iron commercial clips designed for connecting wood members.

2.2.4 Expansion Shields

Type and size best suited for intended use.

2.2.5 Joist Hangers

Steel or iron, zinc-coated, size to fit members where used, sufficient strength to develop the full strength of supported member, complete with any special nails required.

2.2.6 Metal Bridging

Optional to wood bridging; zinc-coated steel, size and design to provide rigidity equivalent to specified wood bridging.

2.2.7 Nails and Staples

ASTM F 547, size and type best suited for purpose; staples shall be as recommended by the manufacturer of the materials to be joined. For sheathing and subflooring, length of nails shall be sufficient to extend 1 inch into supports. In general, 8-penny or larger nails shall be used for nailing through 1 inch thick lumber and for toe nailing 2 inch thick lumber; 16-penny or larger nails shall be used for nailing through 2 inch thick lumber. Nails used with treated lumber and sheathing shall be galvanized. Nailing shall be in accordance with the recommended nailing schedule contained in AF&PA T11. Where detailed nailing requirements are not specified, nail size and spacing shall be sufficient to develop an adequate strength for the connection. The connection's strength shall be verified against the nail capacity tables in AF&PA T01. Reasonable judgement backed by experience shall ensure that the designed connection will not cause the wood to split. If a load situation exceeds a reasonable limit for nails, a specialized connector shall be used.

2.2.8 Timber Connectors

Unless otherwise specified, timber connectors shall be in accordance with TPI 1, APA EWS T300C or AITC TC Manual.

2.3 INSULATION

****

NOTE: Show R-value on the drawings. R-values will be the R-values used in the Energy Budget Analysis.

****

Thermal resistance of insulation shall be not less than the R-values shown. R-values shall be determined at 75 degrees F in accordance with ASTM C 518. Insulation shall contain the highest practicable percentage of recovered material which has been recovered or diverted from solid waste, but not including material reused in a manufacturing process. Where two materials have the same price and performance, the one containing the higher recovered material content shall be provided. Insulation shall be the standard product of a manufacturer and factory marked or identified with manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. Materials containing more than one percent asbestos will not be allowed.

2.3.1 Batt or Blanket

****

NOTE: See MIL-HDBK-1008 and local building code for fire retardant classifications required, and for flame spread and smoke developed ratings.

****

2.3.1.1   Glass Fiber Batts and Rolls

Glass fiber batts and rolls shall conform to ASTM C 665, [Type I unfaced insulation] [Type II kraft faced insulation] [Type III foil faced insulation, Class [A] [B], having a UL rating of [25] [50] [and a smoke developed rating of 150 or less when tested in accordance with ASTM E 84]]. Insulation shall have a 10 mil thick, white, puncture resistant woven-glass cloth with vinyl facing on one side. Width and length shall suit construction conditions.

2.3.1.2   Mineral Fiber Batt

Mineral fiber batt shall conform to ASTM C 665, [Type I unfaced insulation] [Type II kraft faced insulation, Class C] [Type III foil faced insulation Class C].

2.3.1.3   Mineral Fiber Blanket

Mineral fiber blanket shall conform to ASTM C 553, Type I, Class 6. Blankets shall be sized to suit construction conditions, resilient type for use below and above ambient temperature to 350 degrees F. Blankets shall have a factory applied vapor-barrrier facing on one side with 2 inch nailing tabs on both edges. Vapor barriers shall be fire retardant, high vapor transmission, and aluminum foil laminated to crepe paper type conforming to ASTM C 1136, Type II. Nominal density shall be 0.75 pcf.

2.3.2   Loose Fill or Granular Fill

2.3.2.1   Vermiculite

Vermiculite shall conform to ASTM C 516, Type II.

2.3.2.2   Perlite

Perlite shall conform to ASTM C 549, Type II with minimum recovered material content of 23 percent by weight of core material.

2.3.2.3   Mineral Fiber

****

NOTE: Blown-in insulation is recommended for use in attics or floors directly over ceilings, in wall spaces where mineral fiber flexible blankets cannot be used.

****

Mineral fiber shall conform to ASTM C 764, Type [I] [II]. Blown-in mineral fiber insulation shall conform to ASTM C 764, Type I, [Category 1, one percent or less loss on ignition] [Category 2, 12 percent or less loss on ignition].

2.3.2.4   Cellulosic or Wood Fiber

****

NOTE: Cellulosic or wood fiber insulation readily absorbs moisture and loses its insulating quality when wet. It also absorbs fire retardant becoming

highly corrosive to iron products when the fire retardant is of a corrosive nature. Cellulosic or wood fiber insulation is not recommended for family housing construction. The use of cellulosic or wood fiber insulation should be limited to dry areas and areas treated with non-corrosive fire retardant.
****

Cellulosic or wood fiber shall conform to ASTM C 739 or 16 CFR 1209with minimum recovered material content of 75 percent by weight of core material.

2.3.3 Sill Sealer

Mineral wool, 1 inch thick and compressible to 1/32 inch, width of sill, designed to perform as an air, dirt, and insect seal in conformance with ASTM C 665, Type I.

2.3.4 Rigid Insulation

2.3.4.1 Polystyrene Board

Polystyrene board shall be extruded and conform to ASTM C 578, Type IV.

2.3.4.2 Polyurethane or Polyisocyanurate Board

Polyurethane or polyisocyanurate board shall have a minimum recovered material content of 9 percent by weight of core material in the polyurethane or polyisocyanurate portion. Unfaced preformed polyurethane shall conform to ASTM C 591. Faced polyisocyanurate shall conform to ASTM C 1289.

2.3.4.3 Glass Fiber or Insulation Board

Glass mat gypsum roof board shall conform to ASTM C 1177/C 1177M, flame spread 0, smoke developed 0, psi 500, water resistant.
Glass fiber or insulation board shall conform to ASTM C 612, Type 1A with a minimum recovered material content of 6 percent by weight of glass fiber core material. For floors receiving a vinyl finish flooring, a separate layer of fully-sanded underlayment shall be installed as provided for above over combination subfloor-underlayment panels.

2.3.4.4 Mineral Fiber Block and Board

Mineral fiber block and board shall conform to ASTM C 612 or ASTM C 726 with a minimum recovered material content of 5 percent by weight of mineral fiber core material.

2.3.4.5 Cellular Glass

Cellular glass shall conform to ASTM C 552.

2.4 VAPOR RETARDER

****
NOTE: The drawings will indicate the location and extent of vapor retarder.
****

Vapor retarder shall be polyethylene sheeting conforming to ASTM E 154 or other equivalent material. Vapor retarder shall have a maximum vapor permeance rating of 0.5 perms as determined in accordance with ASTM E 96, unless otherwise specified.

2.5 AIR INFILTRATION BARRIER

****
NOTE: The drawings will indicate the location and extent of air infiltration barrier.
****

Air infiltration barrier shall be building paper meeting the requirements of ASTM C 1136, Type IV, style optional or a tear and puncture resistant olefin building wrap (polyethylene or polypropylene) with a moisture vapor transmission rate of [125] [_____] g per square meter per 24 hours in accordance with ASTM E 96, Desiccant Method at [23] [_____] degrees C or with a moisture vapor transmission rate of [670] [_____] g per square meter per 24 hours in accordance with ASTM E 96, Water Method at [23] [_____] degrees C.

PART 3 EXECUTION

3.1 INSTALLATION OF FRAMING

3.1.1 General

General framing shall be in accordance with AF&PA T11.Members shall be closely fitted, accurately set to required lines and levels, and rigidly secured in place. Members shall be framed for passage of ducts. Members shall be cut, notched, or bored in accordance with applicable requirements of AF&PA T01 for the passage of pipes, wires, or conduits. Rafters, purlins, and joists shall be set with crown edge up. Framing shall be kept at least 2 inches away from chimneys and 4 inches away from fireplace backwalls. When joists, beams, and girders are placed on masonry or concrete, a wood base plate shall be positioned and leveled with grout. The joist, beam, or girder shall then be placed on the plate. When joists, beams, and girders are set into masonry or concrete, a pocket shall be formed into the wall. The joist, beam, or girder shall then be placed into the pocket and leveled with a steel shim.

3.1.2 Structural Members

Members shall be adequately braced before erection. Members shall be aligned and all connections completed before removal of bracing. Individually wrapped members shall be unwrapped only after adequate protection by a roof or other cover has been provided. Scratches and abrasions of factory-applied sealer shall be treated with two brush coats of the same sealer used at the factory.

3.1.3 Partition and Wall Framing

Unless otherwise shown, studs shall be spaced [16] [24] inches on centers. Studs shall be doubled at openings. Unless otherwise indicated, headers for openings shall be made of two pieces of stud material set on edge or solid lumber of equivalent size, and corners shall be constructed of not less than three full members. End studs of partitions abutting concrete or masonry shall be anchored thereto with expansion bolts, one near each end of each stud and at intermediate intervals of not more than 4 feet.

Plates of partitions resting on concrete floors shall be anchored in place with expansion bolts, one near each end of each piece and at intermediate intervals of not more than 6 feet between bolts. In lieu of expansion bolts, anchoring into concrete may be accomplished with powder-driven threaded studs of suitable type and size and spaced at 3 feet on center. Walls and load bearing partitions shall be provided with double top plates with members lapped at least [2] [4] feet and well spiked together.

3.1.4 Floor (Ceiling) Framing

Except where otherwise indicated joists shall have bearings not less than 4 inches on concrete or masonry and 1-1/2 inches on wood or metal. Joists, trimmers, headers, and beams framing into carrying members at the same relative levels shall be carried on joist hangers. Joists shall be lapped and spiked together at bearings or butted end-to-end with scab ties at joint and spiked to plates. Openings in floors shall be framed with headers and trimmers. Headers carrying more than two tail joists and trimmers supporting headers carrying more than one tail joist shall be doubled, unless otherwise indicated. Joists shall be doubled under partitions parallel with floor joists. Joists built into masonry shall be provided with [a beveled fire cut so that the top of the joist does not enter the wall more than 1 inch] [or] [standard steel wall bearing boxes]. Engineered wood joists shall be installed in accordance with distributor's instructions.

3.1.5 Roof Framing or Rafters

Tops of supports or rafters shall form a true plane. Valley, ridge, and hip members shall be of depth equal to cut on rafters where practicable, but in no case less than depth of rafters. Valleys, hips, and ridges shall be straight and true intersections of roof planes. Necessary crickets and watersheds shall be formed. Rafters, except hip and valley rafters, shall be [spiked to wall plate and to ceiling joists with no less than three 8-penny nails] [bolted by angles]. Rafters shall be toe-nailed to ridge, valley, or hip members with at least three 8-penny nails. Rafters shall be braced to prevent movement until permanent bracing, decking or sheathing is installed. Hip and valley rafters shall be secured to wall plates by clip angles. Openings in roof shall be framed with headers and trimmers. Unless otherwise indicated, headers carrying more than two rafters and trimmers supporting headers carrying more than one rafter shall be double. Hip rafters longer than the available lumber shall be butt jointed and scabbed. Valley rafters longer than the available lumber shall be double, with pieces lapped not less than 4 feet and well spiked together. Trussed rafters shall be installed in accordance with TPI Bklet HIB. Engineered wood joists shall be installed in accordance with distributor's instructions.

3.1.6 Stair Framing

****

NOTE: Normally a minimum of three rough carriages will be required. However, design conditions will govern, and the number of carriages required will be shown on the drawings.

****

Stair framing members shall be well spiked together. Rough carriages shall be cut to exact shape required to receive finish treads and risers. Risers shall be of uniform height, and treads shall be of uniform width except as otherwise shown. Trimmers, blocking, and other framing necessary for support of finish treads, risers, newels, and railing shall be provided.

3.2 INSTALLATION OF SHEATHING

3.2.1 Fiberboard

Sheathing shall be applied with edges 1/8 inch apart at joints, fitted snugly at abutting frames of openings, and nailed or stapled in accordance with the manufacturer's approved instructions. Sheets shall be applied vertically, extended over top and bottom plates, and with all vertical and horizontal joints over supports.

3.2.2 Gypsum Board

Sheathing shall be applied with edges in light contact at joints and nailed in accordance with the manufacturer's approved instructions. Sheets 2 feet wide shall be applied horizontally with tongued edge up, with vertical joints over supports, and with vertical joints staggered. Sheets 4 feet wide shall be applied vertically, extended over top and bottom plates, and with all vertical and horizontal joints over supports.

3.2.3 Plywood and Wood Structural Panels

Sheathing shall be applied with edges 1/8 inch apart at side and end joints, and nailed at supported edges at 6 inches on center and at intermediate supports 12 inches on center unless otherwise shown. Nailing of edges shall be 3/8 inchfrom the edges. Wall sheathing shall extend over top and bottom plates, and if applied horizontally the vertical joints shall be made over supports and staggered. Wall sheathing over which wood shingles are to be applied shall be applied horizontally. Roof sheathing shall be applied with long dimension at right angles to supports, end joints made over supports, and end joints staggered.

3.2.4 Wood

Sheathing end joints shall be made over framing members and so alternated that there will be at least two boards between joints on the same support. Each board shall bear on at least three supports. Boards shall be nailed at each support using two nails for boards 6 inches and less in width and three nails for boards more than 6 inches in width. Roof sheathing shall not be installed where roof decking is installed.

3.3 INSTALLATION OF SUBFLOORING

3.3.1 Plywood and Wood Structural Panel

Subflooring shall be applied with long dimension at right angles to the supports, with edges 1/8 inch apart at side and end joints, and nailed at supported edges 6 inches on center and at intermediate supports 12 inches on center unless otherwise shown. Subflooring may be installed with adhesive conforming to ASTM D 3498 and nails spaced at 12 inches on center unless otherwise shown. Each panel shall have end joints made over supports and end joints staggered. Where finish flooring of different thicknesses is used in adjoining areas, wood strips of the thickness required to bring the finish flooring surfaces into the same plane shall be used under the plywood subfloor.

3.3.2 Wood

Subflooring shall be applied diagonally with end joints made over supports. Each board shall bear on at least three supports and shall be nailed at each support using two nails for boards 6 inches and less in width and three nails for boards more than 6 inches in width.

3.4 INSTALLATION OF UNDERLAYMENT

3.4.1 Hardboard

Underlayment shall be applied with edges 1/32 inch apart at joints and nailed at edges 6 inches on center and at 6 inches on center throughout remainder of panel. Nailing at edges shall be 3/8 inch from edges. A clearance of 1/4 inch shall be provided at walls. Joints of underlayment shall not be located directly over parallel joints of subflooring. Power-driven wire staples of lengths recommended by the underlayment manufacturer may be used in lieu of nails. Any surface roughness at nail heads or joints shall be lightly sanded to blend with the undisturbed surface.

3.4.2 Particleboard

Underlayment shall be applied with edges 1/32 inch apart at joints and nailed at edges 6 inches on center and at 10 inches on center throughout remainder of panel. Nailing at edges shall be 3/8 inch from edges. A clearance of 1/4 inch shall be provided at walls. Joints of underlayment shall not be located directly over parallel joints of subflooring. Power-driven wire staples of lengths recommended by the underlayment manufacturer may be used in lieu of nails. Any surface roughness at nail heads or joints shall be lightly sanded to blend with the undisturbed surface.

3.4.3 Plywood

Underlayment shall be applied with edges 1/32 inch apart at joints and nailed at edges 6 inches on center and at 8 inches on center throughout remainder of panel for panels 11/32 inch and thicker. Thinner panels shall be nailed at edges 3 inches on center and at 6 inches on center throughout remainder of panel. Nailing at edges shall be 3/8 inch from edges. A clearance of 1/4 inch shall be provided at walls. Joints of underlayment shall not be located directly over parallel joints of subflooring. Power-driven wire staples of lengths recommended by the underlayment manufacturer may be used in lieu of nails. When plywood combination subfloor-underlayment is used in lieu of separate layers, it shall be installed as specified for plywood subfloor, except all joints shall be made over supports with edge and joints spaced 1/8 inch apart. When plywood combination subfloor-underlayment is tongued and grooved, only end joints shall require support. Tongued and grooved combination subfloor-underlayment shall be applied with joints spaced 1/8 inch apart. Any surface roughness at nail heads or joints shall be lightly sanded to blend with the undisturbed surface.

3.5 INSTALLATION OF SHEAR WALLS

Plywood or wood structural panels shall be installed with the long dimension parallel or perpendicular to the supports. Blocking shall be provided behind edges not located over supports. Shear wall construction, nailing, and top and bottom anchorage shall be as shown.

3.6 INSTALLATION OF MISCELLANEOUS WOOD MEMBERS

3.6.1 Bridging

Wood bridging shall have ends accurately bevel-cut to afford firm contact and shall be nailed at each end with two nails. Metal bridging shall be installed as recommended by the manufacturer. The lower ends of bridging shall be driven up tight and secured after subflooring or roof sheathing has been laid and partition framing installed.

3.6.2 Corner Bracing

Corner bracing shall be installed when required by type of sheathing used or when siding, other than panel siding, is applied directly to studs. Corner bracing shall be let into the exterior surfaces of the studs at an angle of approximately 45 degrees, shall extend completely over wall plates, and shall be secured at each bearing with two nails.

3.6.3 Blocking

Blocking shall be provided as necessary for application of siding, sheathing, subflooring, wallboard, and other materials or building items, and to provide firestopping. Blocking for firestopping shall ensure a maximum dimension of 8 feet for any concealed space. Blocking shall be cut to fit between framing members and rigidly nailed thereto.

3.6.4 Nailers and Nailing Strips

Nailers and nailing strips shall be provided as necessary for the attachment of finish materials. Nailers used in conjunction with roof deck installation shall be installed flush with the roof deck system. Stacked nailers shall be assembled with spikes or nails spaced not more than 18 inches on center and staggered. Beginning and ending nails shall not be more than 6 inches for nailer end. Ends of stacked nailers shall be offset approximately 12 inches in long runs and alternated at corners. Anchors shall extend through the entire thickness of the nailer. Strips shall be run in lengths as long as practicable, butt jointed, cut into wood framing members when necessary, and rigidly secured in place. Nailers and nailer installation for Factory Mutual wind uplift rated roof systems specified in other Sections of these specifications shall conform to the recommendations contained in FM LPD 1-49.

3.6.5 Wood Grounds

Wood grounds shall be provided as necessary for attachment of trim, finish, and other work to plaster. Grounds shall be run in lengths as long as practicable, butt jointed, and rigidly secured in place.

3.6.6 Furring Strips

Furring strips shall be provided at the locations shown. Furring strips shall be installed at 16 inches on center unless otherwise shown, run in lengths as long as practicable, butt jointed and rigidly secured in place.

3.6.7 Rough Bucks and Frames

Rough bucks shall be set straight, true, and plumb, and secured with anchors near top and bottom of each wood member and at intermediate intervals of not more than 3 feet. Anchors for concrete shall be expansion bolts, and anchors for masonry shall be 3/16 x 1-1/4 inch steel straps extending not less than 8 inches into the masonry and turned down 2 inches into the masonry.

3.6.8 Wood Bumpers

Wood bumpers shall be bored, countersunk and securely bolted in place.

3.6.9 Sill Plates

Sill plates shall be set level and square and anchor bolted at not more than 6 feet on centers and not more than 12 inches from end of each piece. A minimum of two anchors shall be used for each piece.

3.7 INSTALLATION OF TIMBER CONNECTORS

Installation of timber connectors shall conform to applicable requirements of AF&PA T01.

3.8 INSTALLATION OF INSULATION

Insulation shall be installed after construction has advanced to a point that the installed insulation will not be damaged by remaining work. For thermal insulation the actual installed thickness shall provide the R-values shown. For acoustical insulation the installed thickness shall be as shown. Insulation shall be installed on the weather side of such items as electrical boxes and water lines. Unless otherwise specified, installation shall be in accordance with the manufacturer's recommendation.

3.9 INSTALLATION OF VAPOR RETARDER

Vapor retarder shall be applied to provide a continuous barrier at window and door frames, and at all penetrations such as electrical outlets and switches, plumbing connections, and utility service penetrations. Joints in the vapor retarder shall be lapped and sealed according to the manufacturer's recommendations.

3.10 INSTALLATION OF AIR INFILTRATION BARRIER

Air infiltration barrier shall be installed in accordance with the manufacturer's recommendations.

TABLE I. SPECIES AND GRADE

Subflooring, Roof Sheathing, Wall Sheathing, Furring

Grading Rules	Species	Const Standard	No. 2 Comm	No. 2 Board Comm	No. 3 Comm
NHLA Rules					
	Cypress			X	
NELMA Grading Rules					
	Northern White Cedar				X
	Eastern White Pine	X			
	Northern Pine	X			
	Balsam Fir				X
	Eastern Hemlock-				X

TABLE I. SPECIES AND GRADE

Subflooring, Roof Sheathing, Wall Sheathing, Furring

Grading Rules	Species	Const Standard	No. 2 Comm	No. 2 Board Comm	No. 3 Comm
	Tamarack				
CRA RIS-01-SS					
	Redwood		X		
SCMA Specs					
	Cypress			X	
SPIB Rules					
	Southern Pine		X		
WCLIB Std 17					
	Douglas Fir-Larch	X			
	Hem-Fir	X			
	Sitka Spruce	X			
	Mountain Hemlock	X			
	Western Cedar	X			
WWPA Grading Rules					
	Douglas Fir-Larch	X			
	Hem-Fir	X			
	Idaho White Pine	X			
	Lodgepole Pine			X	
	Ponderosa Pine			X	
	Sugar Pine			X	
	Englemann Spruce			X	
	Douglas Fir South			X	
	Mountain Hemlock			X	
	Subalpine Fir			X	
	Western Cedar			X	

TABLE II. SPECIES AND GRADE

Wood Bumpers

Grading Rules	Species	No. 1	No. 2
NHLA Rules			
	Red Oak	X	
NELMA Grading Rules			
	Northern Pine		X
	Eastern Hemlock-Tamarack		X
SPIB Rules			
	Southern Pine	X	
WCLIB Std 17			
	Douglas Fir-Larch		X

TABLE II. SPECIES AND GRADE

Wood Bumpers

Grading Rules	Species	No. 1	No. 2
	Hem-Fir		X
WWPA Grading Rules			
	Douglas Fir-Larch		X
	Hem-Fir		X
	Douglas Fir-South		X

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-06200 (September 1996)**
U.S. ARMY CORPS OF ENGINEERS **---------------------------**
Superseding
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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 06200

FINISH CARPENTRY
09/96

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NOTE: This guide specification covers the requirements for finish carpentry. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for fire-retardant treatment, siding, epoxy-aggregate panels, soffits, fascias and trim, moldings, wood shingles, and woodwork items. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

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NOTE: Designer should require materials, products, and innovative construction methods and techniques which are environmentally sensitive, take advantage of recycling and conserve natural resources.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.6	(1998) Hardboard Siding

APA-THE ENGINEERED WOOD ASSOCIATION (APA)

APA E445	(1994; Rev Oct 1997) Performance Standards and Policies for Structural-Use Panels

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1435	(1994) Outdoor Weathering of Plastics
ASTM D 2898	(1996) Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
ASTM D 3679	(1996) Rigid Poly(Vinyl Chloride) (PVC) Siding
ASTM F 547	(1977; R 1990) Definitions of Terms Relating to Nails for Use with Wood and Wood-Base Materials

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C9	(1997) Plywood - Preservative Treatment by Pressure Processes
AWPA C20	(1996) Structural Lumber Fire-Retardant Pressure Treatment
AWPA C27	(1996) Plywood - Fire-Retardant Pressure Treatment
AWPA M4	(1996) Standard for the Care of Preservative-Treated Wood Products
AWPA P5	(1997) Standards for Waterborne

Preservatives

ARCHITECTURAL WOODWORK INSTITUTE (AWI)

AWI Qual Stds	(1994) Architectural Woodwork Quality Standards, Guide Specifications and Quality Certification Program

CALIFORNIA REDWOOD ASSOCIATION (CRA)

CRA RIS-01-SS	(1997) Standard Specifications for Grades of California Redwood Lumber

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1	(1996) Voluntary Product Standard - Construction and Industrial Plywood
DOC PS 2	(1992) Performance Standard for Wood-based Structural-Use Panels

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

NELMA Grading Rules	(1997) Standard Grading Rules for Northeastern Lumber

SOUTHERN CYPRESS MANUFACTURER'S ASSOCIATION (SCMA)

SCMA Specs	(1986; Supple No. 1, Aug 1993) Standard Specifications for Grades of Southern Cypress

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB Rules	(1994;Supple 8 thru 11) Standard Grading Rules for Southern Pine Lumber

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB Std 17	(1996; Supples VII(A-E), VIII(A-C)) Grading Rules For West Coast Lumber

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA Grading Rules	(1995; Supple Nos. 1 thru 5)Western Lumber Grading Rules 95

WOOD MOULDING AND MILLWORK PRODUCERS ASSOCIATION (WMMPA)

WMMPA WM 6	(1987) Industry Standard for Non-Pressure Treating of Wood Millwork

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item

should be required.

NOTE: Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Siding; [_____]. Epoxy-Aggregate Panels; [_____].

Manufacturer's printed data, showing texture, density, catalog cuts, and installation instructions.

Wood Items, Siding, and Trim; [_____].
Manufacturer's printed data indicating the usage of engineered or recycled wood products, and environmentally safe preservatives.

SD-04 Drawings

Finish Carpentry; [_____].

Drawings showing fabricated items and special mill and woodwork items. Drawings shall indicate materials and details of construction, methods of fastening, erection, and installation.

SD-14 Samples

Siding; [_____]. Wood Shingles; [_____]. Moldings; [_____]. Fascias and Trim; [_____].

Samples shall be of sufficient size to show patterns, color ranges, and types, as applicable, of the material proposed to be used.

1.3 DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition, stored off ground in fully covered, well-ventilated areas, and protected from extreme changes in temperature and humidity.

PART 2 PRODUCTS

2.1 WOOD ITEMS, SIDING, AND TRIM

The Contractor shall furnish products which optimize design by reducing the amount of wood used (engineered wood), or recycled wood products, and preservatives without arsenic or chromium when the products and methods are competitive in price or directed by the Contracting Officer.

2.1.1 Grading and Marking

Materials shall bear the grademark, stamp or other identifying marks indicating grades of material and rules or standards under which produced.

Such identifying marks on a material shall be in accordance with the rule or standard under which the material is produced, including requirements for qualifications and authority of the inspection organization, usage of authorized identification, and information included in the identification. The inspection agency for lumber shall be certified by the Board of Review, American Lumber Standards Committee, to grade the species used. Except for plywood, wood structural panels, and lumber, bundle marking will be permitted in lieu of marking each individual piece. Surfaces that are to be architecturally exposed to view shall not bear grademarks, stamps, or other types of identifying marks.

2.1.2 Sizes and Patterns

Lumber sizes and patterns shall conform to rules or standards under which produced. Unless otherwise specified, lumber shall be surfaced on four sides. Sizes and patterns for materials other than lumber shall conform to requirements of the rules or standards under which produced. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.

2.1.3 Moisture Content

The maximum moisture content of untreated trim and wood siding shall be 15 percent at the time of delivery to the jobsite and when installed. Moisture content of all other material shall be in accordance with the standard under which the product is produced.

2.1.4 Preservative Treatment

2.1.4.1 Plywood

Plywood shall be treated in accordance with AWPA C9 with waterborne preservatives listed in AWPA P5 to a retention level as follows:

a. 0.25 pcf intended for above ground use.

b. 0.4 pcf intended for ground contact and fresh water use.

2.1.4.2 Exterior Wood Molding and Millwork

Exterior wood molding and millwork within 18 inches of soil, in contact with water or concrete shall be preservative-treated in accordance with WMMPA WM 6. Exposed areas of treated wood that are cut or drilled after treatment shall receive a field treatment in accordance with AWPA M4. Items of all-heart material of cedar, cypress, or redwood will not require preservative treatment, except when in direct contact with soil.

2.1.5 Fire-Retardant Treatment

****

NOTE: List items to be treated. Fire-retardant treatment will be specified for exposed plywood when a flame spread rating of 25 or less is required.

Fire-retardant treated plywood will be used only for nonstructural applications which are not subject to elevated temperature or high humidity.
Fire-retardant treated plywood will not be used in

any part of the roof or roofing system.
****

Fire-retardant treated lumber shall be pressure treated in accordance with AWPA C20. Fire-retardant treated plywood shall be pressure treated in accordance with AWPA C27. Material use shall be defined in AWPA C20 and AWPA C27 for Interior Type [A] [and] [B] and Exterior Type. Treatment and performance inspection shall be by a qualified independent testing agency that establishes performance ratings. Each piece or bundle of treated material shall bear identification of the testing agency to indicate performance with such rating. Treated materials to be exposed to rain wetting shall be subjected to an accelerated weathering technique in accordance with ASTM D 2898, Method A, prior to being tested for compliance with AWPA C20 or AWPA C27. Items to be treated include: [_____].

2.1.6 Siding

****
NOTE: Plywood, wood structural panel, hardboard, and wood will be retained as optional materials for a particular type of siding whenever practicable.

Medium-density overlay will not be specified for rough-sawn texture face panels or panels that are to receive semitransparent stain or a natural finish.
****

Horizontal siding shall be hardboard, plywood, wood structural panel, wood or vinyl. Panel siding shall be hardboard, wood structural panel, or plywood.

2.1.6.1 Horizontal Hardboard Siding

Horizontal hardboard siding shall be made from basic hardboard specified in AHA A135.6, factory primed face and longitudinal edges, factory applied back, lap type, [8] [9] [10] [12] incheswide, maximum practicable lengths, 3/8 inch or 7/16 inch thick, [smooth] [embossed] [textured] face.

2.1.6.2 Horizontal Plywood Siding

Horizontal plywood siding shall conform to DOC PS 1, exterior, [medium-density overlay] lap type, [6] [8] [12] inches wide, maximum practicable lengths, [3/8] [7/16] [15/32] [1/2] inch thick, [smooth] [rough-sawn texture] [embossed] face.

2.1.6.3 Wood Siding

Wood siding shall be of the species and grades listed in TABLE I at the end of this section. Siding shall be [horizontal bevel type, minimum 3/16 inch thin edge by minimum 7/16 inch thick edge,] [horizontal plain lap type] [horizontal drop type] [vertical board, tongue and groove or shiplap on long edges,] [vertical board and batten type,] 1 inch thick, [6] [8] [10] inches wide, maximum practicable lengths, [smooth] [rough-sawn texture] face.

2.1.6.4 Vinyl Siding

Vinyl siding shall be manufactured to withstand outdoor weathering in accordance with ASTM D 1435 and shall meet the physical requirements of ASTM D 3679. The minimum thickness of the siding shall be 0.035 inches. Horizontal and vertical siding panels shall be between 8 and 10 inches in width depending on the configuration of the panel. Panels shall have a uniform color on the surface and throughout the thickness of the panel. Panels shall have a [wood grain] [smooth] [matte] surface.

2.1.6.5   Panel Hardboard Siding

Panel hardboard siding shall be made from basic hardboard specified in AHA A135.6, factory primed face, factory applied back, 4 feet wide, maximum practicable lengths, 3/8 inchor 7/16 inch thick, [smooth] [embossed] face [, and grooved as selected from manufacturer's standard patterns].

2.1.6.6   Panel Plywood Siding

Panel plywood siding shall conform to DOC PS 1, exterior [medium-density overlay,] 4 feet wide, maximum practicable lengths, span rating of [16] [24] inch on centers, [smooth] [embossed] [rough-sawn texture] [striated] face, [and grooved] [as selected from manufacturer's standard patterns].

2.1.6.7   Horizontal Rated Siding

Rated horizontal siding shall be qualified under APA E445, exterior type [medium-density overlay], lap types, [6] [8] [10] [12] inches wide, maximum practicable lengths, [7/16] [15/32] [1/2] inchthick, [smooth] [embossed] [rough-sawn texture] face.

2.1.6.8   Panel Rated Siding

Rated panel siding shall be qualified under APA E445, exterior type, [medium-density overlay] 4 feet wide, maximum practicable lengths, [span rated at 16 inch on centers,] [span rated at 24 inch on centers,] [smooth] [embossed] [striated] face [, and grooves] as selected from manufacturer's standard patterns.

2.1.6.9   Wood Structural Panels

Wood Structural Panels shall conform to DOC PS 2, exterior, exposure [1] [2], [single-faced] [double-faced], 4 feet wide, maximum practicable lengths, selected from manufacturer's standard patterns to satisfy the wind load for the specified span.

2.1.7   Epoxy-Aggregate Panels

****

NOTE: Epoxy-aggregate coated panels may be included in the design for architectural purposes and then only as accent and spandrel panels. If not included in the design, delete this information.

****

Prefinished epoxy-aggregate panels shall consist of an asbestos-free cement board base sheet with a factory applied surface of epoxy resins and decorative natural stone chips. Factory applied finish shall be a minimum of 20 mils of 100 percent solids, two-component epoxy resin-based coating followed by an application of inert aggregate. Stone color shall be selected from manufacturer's standard colors. Cement board base sheet shall be a minimum of 1/4 inch thick. Finished panels shall be dimensionally stable. Water absorption on the surfaced side shall not exceed 0.20 percent after 24 hours of submergence in water. Accessories shall be manufacturer's standard extruded matching color aluminum moldings. Moldings shall be provided for meeting strips, end caps, inside corners, or outside corners. Fasteners shall be noncorrosive, self-tapping screw type and finished to match the color of stone. Caulking compound shall be color compatible, low modulus silicone or urethane type.

2.1.8 Soffits

2.1.8.1 Hardboard and Plywood

Hardboard and plywood soffits shall be siding grade hardboard, 3/8 or 7/16 inch thick; plywood, DOC PS 1, exterior type, [Grade A-C] [plywood panel siding] [rated siding], [11/32 inch thick for 24 inch on centers] [15/32 inch thick for 32 inch on centers] [19/32 inch thick for 48 inch on centers] maximum span with all edges supported.

2.1.8.2 Vinyl

Vinyl soffits shall be manufactured to withstand outdoor weathering in accordance with ASTM D 1435 and shall meet the physical requirements of ASTM D 3679. Panels shall be [solid] [vented] and shall have [smooth] [matte] surface.

2.1.9 Fascias and Trim

2.1.9.1 Wood

Fascias and trim, including exterior door and window casing, shall be species and grade listed in TABLE I at the end of this section. Sizes shall be as indicated. Metal corners may be furnished in lieu of wood cornerboards for horizontal siding; and if furnished, shall be galvanized steel and primed or aluminum and primed.

2.1.9.2 Vinyl

Vinyl trim, including exterior door and window casing and moldings, shall meet the pertinent requirements specified for vinyl siding and soffits.

2.1.10 Moldings

Moldings shall be of the pattern indicated and shall be of a grade compatible with the finish specified.

2.1.11 Wood Shingles

****

NOTE: Selection of wood shingles will be based on climatic conditions at the job site. Besides fire resistance, factors to be considered are: wind, fungus, rot and termite resistance plus tear strength and whether the shingles are sealing or not.

****

Wood shingles shall be No. 1 Grade, Red Cedar, Tidewater Red Cypress or California Redwood in accordance with applicable grading rules under which it is produced, random widths, [16] [18] [24] inches length, dip-stained at factory in color selected from manufacturer's standards colors.

2.1.12   Woodwork Items

****
NOTE: Materials and fabrication requirements for woodwork items not listed in this guide specification will be added or modified as necessary for the project.
****

2.1.12.1   Bulletin Boards

Bulletin boards shall have a hardwood or aluminum frame, 1/4 inch thick plywood or hardboard back; and a 1/4 inch thick, dense, smooth faced corkboard face securely cemented to the back.

2.1.12.2   Chalkboards

Chalkboards shall have a hardwood or aluminum frame and 1/4 inch thick writing surface of [selected chalkboard slate with surface ground to a true plane] [cast acrylic plastic plate glass with color fused to surface] [porcelain enamel laminated to plywood]. Color shall be [black] [green].

2.1.12.3   Utility Shelving

Utility shelving shall be a suitable species equal to or exceeding requirements of No. 3 Common white fir under WWPA Grading Rules, 1 inch thick; or plywood, interior type, Grade A-B, 1/2 inch thick, any species group.

2.1.12.4   Workbench

Workbench shall have a work surface of [1/4 inchtempered hardboard] [1/4 inch particle board] [1/4 inch solid core plywood with sanded face] [18 gauge steel with gray enamel finish] over 2 inch thick lumber backing. Base shall be 14 gauge steel with legs adjustable to 1 inch increments to adjust the work surface from 30 to 36 inches.

2.2   NAILS

Nails shall be the size and type best suited for the purpose and shall conform to ASTM F 547. Nails shall be hot-dip galvanized or aluminum when used on exterior work. For siding, length of nails shall be sufficient to extend 1-1/2 inches into supports, including wood sheathing over framing. Screws for use where nailing is impractical shall be size best suited for purpose.

PART 3   EXECUTION

3.1   GENERAL

3.1.1   Installation of Siding

Siding shall be accurately fitted and positioned without springing or otherwise forcing siding in place. [Siding to have a stain finish shall have nails set and stopped with nonstaining putty to match finished siding.] [Siding to have a paint finish shall have nails driven flush.]

3.1.2   Horizontal Siding

****
NOTE: Only one nail at each support is used to attach 150 mm (6 inch) or less wide siding. Edit paragraph accordingly.
****

End joints shall be made over framing members and be so alternated that at least two boards will be between joints on the same support. Shorter pieces shall be uniformly distributed throughout each area. Starter strips shall be provided as necessary to establish proper slant for siding. Ends of siding shall be predrilled if necessary to prevent splitting when nailed. [Horizontal bevel or plain lap siding shall be overlapped and nailed into each support in accordance with approved recommendations of the siding manufacturer.] [Horizontal drop siding shall have each course fully worked into the top edge of the previous course, and shall be nailed into each support with [two nails, one near the lower edge to clear top of previous course, and one just above mid-height of course.] [one nail just above mid-height of course.]] Vinyl siding shall be fastened to a starter strip at the locking hem. Each subsequent course shall be interlocked at the locking hem to the adjoining panel and nailed to the subtrate on the nailing flange. Nails shall be placed at the center of the slots on the nailing flange, and loosely nailed to allow movement in the panel.

3.1.3 Vertical Board Siding

****
NOTE: Only one nail at each support is used to attach 150 mm (6 inch) or less wide siding. Edit last sentence accordingly.
****

Siding shall be applied with horizontal joints only at locations indicated. Each board shall be fully worked into the edge of previous course, and shall be nailed into supports at 24 inches on centers with [two nails, one blind if possible at or near joint with the previous board, and one just outside the board centerline.] [one nail just outside the board center line.]

3.1.4 Vertical Board and Batten Siding

Siding shall be applied with horizontal joints only at locations indicated. Each board shall be installed with 1/2 inch space between it and the previous board, and nailed at the center of the board and into supports at 24 inches on center. Battens shall be centered over the space between boards and nailed down the center at 16 inches on center.

3.1.5 Panel Siding

Panels shall be applied with edges at joints spaced in accordance with manufacturer's recommendations. Shiplapped edges or square edges covered with battens shall be [primed for paint finish,] [sealed for stain finish,] and all edges shall be backed with framing members. Panels shall be nailed at edges at 6 inches on center and at intermediate supports at 12 inches on center unless otherwise shown. Nailing at edges shall be 3/8 inch from edges. For shiplap joints, nailing shall be 3/8 inch from the visible joint and at a location to penetrate lap with previous panel. When panel siding is part of an engineered shear wall or used as wall-bracing, shiplap joints shall be nailed to supports with double rows of nails. Battens shall be spaced at [12] [16] inches on centers and nailed down the center at 24 inches on center.

3.1.6 Epoxy-Aggregate Coated Panels

Panels shall be installed where shown. Installation shall be as recommended by the manufacturer of the panels.

3.2 SOFFITS

3.2.1 Wood

Panels shall be applied with edges at joints spaced in accordance with manufacturer's instructions and with all edges backed with framing members. Panels shall be nailed 3/8 inch from edges at 6 inches on center and at intermediate supports at 12 incheson center. Panels shall be installed using the maximum practical lengths.

3.2.2 Vinyl

Vinyl soffits shall rest in a "j" channel at each end of the soffit panel. Each panel shall be interlocked at the locking hem and nailed to a support at the nailing flange. Nails shall be placed at the center of the slots on the nailing flange, and loosely nailed to allow movement in the panel.

3.3 FASCIAS AND EXTERIOR TRIM

Exposed surfaces and square edges shall be machine sanded, caulked, and constructed to exclude water. Joints of built-up items, in addition to nailing, shall be glued as necessary for weather-resistant construction. End joints in built-up members shall be well distributed. Joints in flat work shall be shouldered. Backs of wide-faced miters shall be held together with metal rings and glue. Fascias and other flat members shall be in maximum practicable lengths. Cornices shall be braced, blocked, and rigidly anchored for support and protection of vertical joints.

3.4 MOLDING AND INTERIOR TRIM

Molding and interior trim shall be installed straight, plumb, level and with closely fitted joints. Exposed surfaces shall be machine sanded at the mill. Molded work shall be coped at returns and interior angles and mitered at external corners. Intersections of flatwork shall be shouldered to ease any inherent changes in plane. Window and door trim shall be provided in single lengths. Blind nailing shall be used to the extent practicable, and face nailing shall be set and stopped with a nonstaining putty to match the finish applied. Screws shall be used for attachment to metal; setting and stopping of screws shall be of the same quality as required where nails are used.

3.5 FINISH STAIRWORK

****

NOTE: Details on drawings should indicate balusters set into treads and landings, and newels anchored to rough stair framing.

****

Finish stairwork shall conform to AWI Qual Stds, [Premium Grade for transparent] [Custom Grade for opaque] finish. Stairwork shall be erected to form a strong, rigid structure without squeaks or vibrations. Railings shall be secured with concealed fasteners. Wall rails shall be supported on metal brackets spaced near ends and not over 5 feet on centers.

3.6 WOOD SHINGLES

****

NOTE: Weather exposure should be 190 mm (7-1/2 inches) for 400 mm (16 inch) shingles, 215 mm (8-1/2 inches) for 450 mm (18 inch) shingles, and 290 mm (11-1/2 inches) for 600 mm (24 inch) shingles. If roof slope is over 18 degrees, 330 mm per meter (4 in 12), exposure should be 125 mm (5 inch), 140 mm (5-1/2 inch), and 190 mm (7-1/2 inch) for the same length of shingles.

In snow areas the minimum recommended roof slope is 330 mm per meter (4 in 12); in non-snow areas is 300 mm per meter (3 in 12).

****

Wood shingles shall be applied by single-coursing method and with a weather exposure of [7-1/2] [8-1/2] [11-1/2] inches. Each shingle shall be nailed with two nails 1 inch above butt line of the next course, except shingles more than 8 inches in width shall be nailed with three nails. Starter course shall be doubled, and vertical joints shall be offset from vertical joints of the previous course. Corners shall be [mitered over flashing] [abutted to a cedar or redwood strip at the corner] as indicated.

3.7 WOODWORK ITEMS

3.7.1 Bulletin Boards and Chalkboards

Items shall be installed in accordance with the manufacturer's recommendation.

3.7.2 Shelving

Shelving shall be anchored to supporting construction. Unless otherwise indicated, shelves shall be supported by wall-supported brackets not more than 24 inches on center or as required to limit deflection to 1/4 inch between supports with a load of 35 lb per lineal foot. Adjustable shelf hardware shall be steel standards, channel shaped, with 1 inch adjustment slots and brackets designed for attachment to standards.

3.7.3 Clothes Hanger Rods

Rods shall be provided where indicated and in all closets having hook strips. Rods shall be [hardwood 1-1/2 inches in diameter] [aluminum pipe or tubing 1 inch in diameter] [zinc-coated steel pipe 1 inch in diameter]. Rods shall be set parallel with the front edges of the shelving, and shall be supported at each end by suitable sockets, and by intermediate brackets spaced at not more than 4 foot centers.

3.7.4 Workbenches

****

NOTE: Where a natural finish without the use of stain is required for interior trim, species suited for a clear natural finish will be specified.
****

Items shall be anchored in place as indicated.

TABLE I. SPECIES AND GRADE TABLES

Grading Rules	Species	Choice	Clear	C Select	C & Better
NELMA Grading Rules	Eastern Cedar				X
	Eastern Hemlock		X		
	Tamarack				X
	Eastern W. Pine				X
	Northern Pine				X
	Eastern Spruce			X	
	Balsam Fir		X		
CRA RIS-01-SS	Redwood				X
SCMA Specs	Cypress				X
SPIB Rules	Southern Pine	X			
WCLIB Std 17	Douglas Fir	X			
	Larch				X
	Hemlock Fir				X
	Mountain Hemlock				X
	Sitka Spruce				X
WWPA Grading Rules	Douglas Fir	X			
	Larch				X
	Hemlock Fir		X		
	Mountain Hemlock				X
	Western Larch		X		
	Idaho White Pine	X			
	Lodgepole Pine		X		
	Ponderosa Pine		X		
	Sugar Pine		X		
	Englemann Spruce		X		
	Douglas Fir South		X		
	Subalpine Fir		X		

NOTE 1: Western Cedar under WCLIB Std 17 shall be Grade B; and under WWPA Grading Rules, Western Cedar shall be Grade B bevel for siding and Grade A for trim.

NOTE 2: Except as specified in NOTE 3 below, siding and exterior trim shall be any of the species listed above. Interior trim shall be any one of the species listed above and the highest grade of the species for stain or natural finish and one grade below highest grade of species for paint finish.

NOTE 3: Southern Yellow Pine, Douglas Fir, Larch, Western Larch, and Tamarack shall not be used where painting is required and may be used on exterior work only when approved and stained with a preservative type stain.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-07240 (June 1993)**
U.S. ARMY CORPS OF ENGINEERS **--------------------------**
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06/93

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SECTION 07240

EXTERIOR INSULATION AND FINISH SYSTEM
06/93

****
NOTE: This guide specification covers the requirements for exterior insulation and finish system which may be applied to concrete, brick, masonry, or to wood or metal frame construction. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: Do not specify exterior insulation and finish systems (EIFS) in areas subject to abuse, such as high traffic or loading dock areas because these systems have a limited resistance to puncture and abrasion. Do not specify EIFS on horizontal surfaces exposed to the weather.

EIFS provides insulation and exterior finish for both new and renovated buildings. The systems are available in two classes, PB and PM, as follows:

(a) Class PB systems use relatively thin, flexible, polymeric coatings over molded expanded polystyrene (MEPS) insulation. The flexible coatings have a good impact resistance but may be easily punctured by sharp objects. The MEPS insulation allows moisture vapor migration, which can either ventilate the system beneficially or allow moisture to attack the substrate. The polymeric coating will deteriorate after prolonged exposure to water. While many PB systems are applied with adhesives only, mechanical fastening is recommended. Class PB systems should be protected from abuse, as with shields, facings, or extra layers of reinforcing fabric. Class PB systems are the least expensive and most widely used of the two classes.

(b) Class PM systems use thick, rigid, cementitious coatings over extruded expanded-polystyrene (XEPS) insulation. Class PM systems are usually more expensive, more durable and heavier than Class PB systems. The XEPS insulation resists moisture penetration; this helps to protect the substrate, but prevents ventilation of the system. Because of the heavier weight of Class PM systems, and difficulty in bonding to the smooth XEPS surfaces, Class PM systems must be mechanically fastened.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 117	(1995) Operating Salt Spray (Fog) Testing Apparatus
ASTM C 67	(1996) Sampling and Testing Brick and Structural Clay Tile
ASTM C 473	(1995) Physical Testing of Gypsum Board Products and Gypsum Lath

ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 920	(1995) Elastomeric Joint Sealants
ASTM C 947	(1989; R 1996) Flexural Properties of Thin-Section Glass-Fiber-Reinforced Concrete (Using Simple Beam With Third-Point Loading)
ASTM C 948	(1981; R 1994) Dry and Wet Bulk Density, Water Absorption and Apparent Porosity of Thin Sections of Glass-Fiber-Reinforced Concrete
ASTM C 1149	(1990) Self-Supported Spray Applied Cellulosic Thermal/Acoustical Insulation, or Both
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 2394	(1983; R 1993) Simulated Service Testing of Wood and Wood-Base Finish Flooring
ASTM E 72	(1995) Conducting Strength Tests of Panels for Building Construction
ASTM E 84	(1996) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM E 136	(1995) Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C
ASTM E 330	(1990) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
ASTM G 23	(1996) Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM G 53	(1996) Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) For Exposure of Nonmetallic Materials

EIFS INDUSTRY MEMBERS ASSOCIATION (EIMA)

EIMA TM 101.86	(1995; Rev Aug 1995) Resistance of Exterior Insulation Finish Systems (EIFS), Class PB to The Effects of Rapid Deformation (Impact)

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO-01	(1997) Uniform Building Code (3 Vol.)

1.2 DESCRIPTION

****

NOTE: Select PB or PM system, color and coarse, medium or fine finish.

Wall sections will indicate construction details to include flashings, terminations at openings or perimeters, and joints with other materials.

Expansion joints are required at building expansion joints, where substrates change and where significant structural movement occurs; and they must be detailed on the drawings.

****

The exterior insulation and finish system (EIFS) shall be a job-fabricated exterior wall covering consisting of insulation, reinforcing fabric, base coat, finish coat, and accessories. The system shall be the standard product of a manufacturer regularly engaged in furnishing exterior insulation and finish systems and shall be installed by an applicator approved by the system manufacturer. EIFS shall be [polymer base, Class PB] [or] [cementitious, Class PM] [as indicated] and shall be [_____] color and [_____] finish.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Test Specimens

Unless otherwise noted, the test specimens shall consist of reinforcement, base coat and finish coat applied in accordance with the manufacturer's printed recommendations to an insulation board common to the system. These test specimens shall be suitably sized for the apparatus used and be allowed to cure for a minimum of 28 days prior to testing.

1.3.2 Flame Spread

Flame spread test samples consist of base coat, fabric and finish coat, mounted on a non-combustible substrate. When tested in accordance with ASTM E 84, the samples shall have a flame spread rating of 25 or less.

1.3.3 Full Scale Wall Fire Test

Full scale wall fire test specimens shall include the complete system with no less than 4 inches of insulation. Test shall be performed in accordance with ICBO-01, Section 17-6. The specimen shall not contribute to significant or horizontal flame spread.

1.3.4 Impact Test

****

NOTE: Impact resistance may be deleted for applications where impact is improbable.

The following classifications and impact ranges have been established by EIMA for EIF systems.

Impact Classification	**Impact Range**
Standard Impact Resistance	**3-6 N-m (25-49 in-lbs)**
Medium Impact Resistance	**6-10 N-m (50-89 in-lbs)**
High Impact Resistance	**10-17 N-m (90-150 in-lbs)**
Ultra High Impact Resist	**Over 17 N-m (150 in-lb)**

****

The exterior insulation and finish system shall have been tested in accordance with EIMA TM 101.86 using a specimen consisting of cured finish system over 1 inch thick insulation with base coat and reinforcing fabric in a complete assembly typical of the project application. Specimen shall withstand an impact of [_____] inch-pounds.

1.3.5 Structural Performance Test

****

NOTE: The required pressure will be based on wind speed specified in Appendix B of TM 5-809-1 for the vicinity. Higher values may be used, based on local experience of wind forces at the site.

****

The system shall have been tested in accordance with ASTM E 330 to minimum positive and negative pressures of [_____] psf. Test panels shall be 4 feet by 4 feet minimum, consisting of the typical system assembly.

1.4 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

Exterior Insulation and Finish System; [_____].

Two copies of manufacturer's standard printed instructions for installation of the system. Instructions shall include manufacturer's recommended details for corner treatment, jambs, sills, openings, joints and other special applications.

SD-08 Statements

Manufacturer's Approval and License; [_____].

Statement from manufacturer attesting that the applicator is approved and licensed to install the system.

SD-09 Reports

Exterior Insulation and Finish System; [_____].

Test Reports indicating that the system complies with the specified performance tests. Tests shall be by an approved, independent testing laboratory.

SD-14 Samples

Exterior Insulation and Finish System; [_____].

Two samples of each exterior insulation and finish system. Each sample shall be one foot square, minimum, and shall be identical to the proposed installation in thickness, color, texture, insulation and workmanship.

1.5 DELIVERY AND STORAGE

Materials shall be delivered to the jobsite in their original unopened packages, clearly marked with the manufacturer's name, brand name, and description of contents. Storage shall be in accordance with the manufacturer's recommendations in a clean, dry, well-ventilated area. Stored materials shall be protected from sunlight, and kept away from excessive heat. Coating materials which would be damaged by freezing shall be kept at a temperature not less than 40 degrees F.Insulation board shall not be exposed to flame or other ignition sources.

PART 2 PRODUCTS

2.1 EXTERIOR CEMENT BOARD

****

NOTE: Exterior cement board will be used in wood or metal stud-type construction or as underlayment for the insulation over uneven concrete or masonry surfaces and may also be used when required to obtain a fire rating for the wall.

****

Exterior cement board shall be a non-combustible exterior grade portland cement product. Board shall be 4 by 8 feet with a minimum 1/2 inch thickness. Boards shall consist of an aggregated portland cement core faced on both surfaces and wrapped on long edges with an embedded polymer-coated glass fiber mesh. Bonding surface shall have rough texture. Exterior cement board shall comply with the following requirements:

Property	Requirement	Test Method
Flexural Strength	750 psi, Min.	ASTM C 947

Property	Requirement	Test Method
Compressive Strength	1250 psi, Min.	ASTM D 2394
Crack Resistance	No cracking	ASTM E 72
Non-combustibility	Pass	ASTM E 136
Flame Spread/Smoke	5/0 max.	ASTM E 84
Water Absorption	15 percent max.	ASTM C 948
Fastener Pull Resistance	120 lb min. (wet or dry)	ASTM C 473

2.2 ADHESIVE

****
NOTE: Adhesive must be supplemented or replaced by mechanical fasteners for Class PM EIFS.
****

Adhesive shall be the manufacturer's standard product, including primer as required, and shall be compatible with the substrate to which the system is applied.

2.3 INSULATION

****
NOTE: Determine the required R-value and show the R-value at the appropriate detail on the drawings. The required R-value will never be less than that used in the Energy Budget Analysis. Computations should use recognized methods in agreement with ASHRAE Handbook, Fundamentals.
****

Insulation shall conform to ASTM C 578, type as recommended by the system manufacturer and shall be compatible with other system components. Insulation shall be aged a minimum of 6 weeks by air drying, or equivalent prior to installation. Insulation shall be a standard product of the manufacturer and shall be factory marked with the manufacturer's name or trade mark, the material specification number, the R-value at 75 degrees F, and thickness. Thickness of insulation shall be based on specified R-value, but no single layer shall be less than 3/4 inch thick. Boards shall be marked individually. The thermal resistance of insulation in the system shall be not less than the R-value shown on the drawings. Insulation for Class PM and insulation extending below grade shall be restricted to a low water vapor permeability grade of extruded polystyrene (type IV or X).

2.4 BASE COAT

Base coat shall be the manufacturer's standard product and shall be compatible with the finish coat.

2.5 REINFORCING FABRIC

Reinforcing fabric shall be balanced, open weave, glass fiber fabric made from twisted multi-end strands specifically treated for compatibility with the other materials of the system.

2.6 MECHANICAL ANCHORS

Mechanical anchors shall be as recommended by the system manufacturer.

2.7 FINISH COATING

Finish coating shall be manufacturer's standard product, uniform in color and conforming to the following requirements. Specimens for tests shall have been cured for a minimum of 28 days.

TEST	RESULTS	METHOD
Abrasion Resistance	528 quarts of sand- slight - smoothing - no loss of film integrity.	ASTM D 968
Accelerated weathering Light and water exposure	2000 hours. No deterioration	ASTM G 23 or ASTM G 53
Mildew-fungus resistance	Expose for 28 days at 95 percent RH, 90 degrees F temperature. No growth of mildew or fungus.	ASTM C 1149
Salt spray resistance	Withstand 300 hours - No deleterious effects.	ASTM B 117
Water vapor	Not more than 18 grains an hour per square foot.	ASTM E 96
Absorption-freeze (Pre-weighed 4" by 8" specimens; 1" insulation, faced with finish coat cured and stored in air; tested with edges and back open).	After 50 cycles - Total weight gain of not more than 6.2 grams. No checking, splitting, or cracking.	ASTM C 67 50 Cycles: 20 hrs. at -9 degrees C; 4-hr. thaw in water

2.8 SEALANT

Sealant shall meet requirements of ASTM C 920, Class 25, and shall be compatible with the finish system. Type, Grade, and Use shall be as recommended by both the sealant manufacturer and the system manufacturer. When required, primer, bond breaker and backstop shall be non-staining, and as recommended by the sealant manufacturer and the system manufacturer.

2.9 ACCESSORIES

Accessories shall conform to the recommendations of the system manufacturer and shall include trim, edging, anchors, sealant and filler rod required for proper installation of the system.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Surface shall be free of oil, loose materials or protrusions which will interfere with the system installation.

3.2 ENVIRONMENTAL CONDITION

Unless a higher temperature is required by the system manufacturer, the ambient air temperature shall be 40 degrees F or greater and rising at the time of installation of the system and shall be predicted to remain at 40 degrees F or greater for at least 24 hours after installation.

3.3 EXTERIOR CEMENT BOARD

Exterior cement board shall be attached to metal studs with self-tapping wafer-head, corrosion resistant screws, nailed to wood studs, or secured to concrete or masonry with approved fasteners. Screws and nails for application of the board shall be spaced not more than 8 inches on each supporting member, and fasteners into concrete or masonry shall be spaced not more than 12 inches apart horizontally and vertically. Fasteners shall be more closely spaced when required for negative wind load resistance. Edges and ends of boards shall be butted snugly with vertical joints staggered to provide full and even support for the insulation.

3.4 INSULATION BOARD AND REINFORCING FABRIC

Unless otherwise specified by the system manufacturer, insulation boards shall be placed horizontally from a level base line. Vertical joints shall be staggered and insulation boards interlocked at corners. Joints of insulation shall be butted tightly. Surfaces of adjacent insulation boards shall be flush at joints. Joints of insulation shall be offset from substrate joints. Reinforcing glass fabric shall be installed in accordance with the manufacturer's instructions.

3.5 ADHESIVE SYSTEM

Primer (if required by the manufacturer) and adhesive shall be prepared and applied with a stainless steel trowel to substrate in accordance with the manufacturer's instructions. The pattern of the reinforcing fabric shall not be visible. Adhesive used with Class PM must be supplemented with mechanical fasteners. Adhesive shall be used without fasteners only with Class PB system and when recommended by the manufacturer.

3.6 BASE COAT

Base coat shall be mixed in accordance with the manufacturer's instructions and applied to insulated wall surfaces, trowelling the material into the reinforcing fabric in a tight coat and doubling back to provide complete coverage of the reinforcing fabric, panel joints and fasteners. Base coat may be used to level out surface areas when permitted by the manufacturer.

3.7 FINISH COATING

Finish coating shall be applied and leveled in one operation. Final texture shall be obtained by trowels, floats, or by spray application as necessary to achieve the required finish. Finish surfaces shall be plane, with no deviation greater than 1/4 inch when tested with a 10 foot straightedge.

3.8 SEALANT

Edges of the exterior insulation and finish system shall be sealed at openings as recommended by the system manufacturer.

-- End of Section --

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02/95

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DEPARTMENT OF THE ARMY | **CEGS-07310 (February 1995)**
U.S. ARMY CORPS OF ENGINEERS | **---------------------------**

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 1 (January 1996)
Includes note relocation Special change (August 1995)
Includes Text Adjustment Change (Section 01300 Reference) (June 1997)

Latest Notice change indicated by CHG tags

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SECTION 07310

SLATE ROOFING
02/95

****

NOTE: This guide specification covers the requirements for slate roofing on new construction and on historic buildings which require replacement, reinstallation, or repair of slate roofs. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic

designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 370	(1992) Copper Sheet and Strip for Building Construction
ASTM C 406	(1989) Roofing Slate
ASTM D 146	(1990) Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing
ASTM D 226	(1994) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 412	(1992) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA-02	(1989) The NRCA Roofing and Waterproofing Manual

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA-02	(1993) Architectural Sheet Metal Manual

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Shop Drawings; [_____].

Drawings showing slate installation and appearance details, flashing details, and nailing patterns for the slates.

SD-08 Statements

Qualifications; [_____].

Documentation showing qualifications of personnel proposed to perform the roofing work, and a listing identifying prior installations completed by the Contractor.

SD-13 Certificates

Certificates of Compliance; [_____].

Certificates of compliance attesting that the materials meet specification requirements.

SD-14 Samples

Roofing Slate and Accessories; [_____].

Three representative shingles to show color range.

Sealants; [_____].

8 ounces of each type.

Underlayment Sheet; [_____].

1 by 1 foot section.

Fasteners; [_____].

Representative samples of each fastener with identifying tags.

1.3 QUALIFICATIONS

The Contractor shall provide qualified workers, trained and experienced in installing slate roofing systems of this configuration, and shall submit documentation of 5 consecutive years of work of this type. The Contractor shall be familiar with and shall perform work in accordance with [SMACNA-02] [and] [NRCA-02.] A list of installations made shall be provided, identifying when, where, and for whom the installations were made.

1.4 DELIVERY, STORAGE AND HANDLING

Materials shall be delivered in manufacturer's unopened bundles and containers with the manufacturer's brand and name marked clearly thereon. Shingles shall be stored in accordance with manufacturer's printed instructions. Roll goods shall be stored on end in an upright position. Immediately before laying, roofing felt shall be stored for 24 hours in an area maintained at a temperature not lower than 50 degrees F.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Environmental Requirements

Slate roofing work shall proceed when existing and forecasted weather conditions permit work to be performed in accordance with manufacturer's recommendations and warranty requirements.

1.5.2 Material Storage

Materials shall not be stored on roof decks in such a manner as to overstress and/or damage the deck and supporting structure. Placing of loads at midspans of framing shall be avoided. Superimposed loads shall be well distributed.

1.5.3 Units of Work

Units of work shall be established, including removal of existing materials, preparation of existing surfaces and application of underlayment and nailers, and related temporary and/or permanent flashing so that the unit of work can be completed prior to the end of each working day.

1.5.4 Temporary Protection Materials

Materials shall be provided and maintained on the site at all times for temporary roofing, flashing, and other protection when delays and/or changed weather conditions do not permit completion of each unit of work prior to the end of each working day. Materials which have been used for temporary roofing, flashing and other protection shall be removed and discarded.

1.6 WARRANTY

A warranty shall be furnished against defects in material and workmanship of slate roof assembly, including related metal flashing for a period of 10 years from date of final acceptance of the work.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Edit these paragraphs to meet project requirements.

****

2.1.1 Existing Slate

Intact and serviceable existing slate materials shall be salvaged and reused whenever possible. New slate being incorporated into existing slate roofs shall match existing as closely as possible. Slate from the same quarry or manufacturer as the original shall be used if possible.

2.1.2 Slate

Slate shall conform to ASTM C 406. Slate shall be Grade A, (ASTM S1), hard, dense rock, punched or drilled for two nails each. Cracked slate shall not be used. Exposed corners shall be full. Broken corners on covered ends which sacrifice nailing strength or the laying of a watertight roof will not be allowed.

2.1.2.1 Standard Thickness Roofing Slate

Slate shall be [[smooth texture] [rough texture]] [3/16 to 1/4 inch thickness] [all [_____] thickness] [[_____] and [_____] intermingled thicknesses]. Slate shall be the following sizes: [[_____] by [_____]] [graduated lengths] [and] [random widths].

2.1.2.2 Graduated Roof Slate

Slate shall be [[smooth texture] [rough texture]] and shall vary in thickness from [_____] at eave to [_____] at ridge; the percentage of each thickness to be respectively [_____]. The thicknesses shall be intermingled in the various courses, modulating from the heavier and thicker slates in the lower courses of the roof to the thinner slates at the ridge. Slate shall be in standard random widths graduated in length from [_____] at eave to [_____] at ridge, and shall be applied with standard 3 inch lap and exposures.

2.1.2.3 Slate Colors

Slate shall be [unfading] [semi-weathering] slate. Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

2.1.3 Membrane

An underlayment membrane shall be furnished on all surfaces to be covered with slate. Membrane shall consist of [asphalt-saturated felt] [or] [high strength composite self-adhering membrane].

2.1.3.1 Roofing Felt

Roofing felt shall be asphalt-saturated rag felt, Type II, No. 30 asphalt felt in accordance with ASTM D 226.

2.1.3.2 Elastomeric Membrane Underlayment

Membrane shall be a cold applied composite self-adhering membrane of not less than 0.004 inch high strength polyethylene film with slip resistant embossing, coated on one side with a thick layer of adhesive-consistency rubberized asphalt, interwound with a disposable silicone coated release sheet. The tensile strength and elongation values shall be not less than 250 psi when tested in accordance with ASTM D 412 and pliability shall be unaffected when tested in accordance with ASTM D 146.

2.1.3.3 Elastomeric Membrane Accessories

Two component urethane, mastic and primer shall be as approved by the membrane manufacturer. Flashing, expansion joint covers, temporary UV protection and corner fillets shall be as recommended by the membrane manufacturer.

2.1.4 Nails

Nails shall be large-headed slater's solid copper nails of Number 10 or 11 gauge metal. Nails shall be 3d for slates 18 inch or less in length; 4d nails shall be used for slates 20 inch or longer, and 6d nails shall be used for slates on hips and ridges. Thicker slates require longer and heavier gauge nails. The proper size shall be determined by adding 1 inch to twice the thickness of the slate. Nails shall be of sufficient length to adequately penetrate the roof sheathing. Nails used to retain copper flashing and slate at rake edges, hips, ridges, and eaves prone to wind damage shall be of the ring shank design.

2.1.5 Flashing

Flashing shall be 20 ounce, light cold-rolled temper (H00) copper conforming to ASTM B 370. Flashing shall be in accordance with the requirements as specified in Section 07600 SHEET METALWORK, GENERAL.

2.1.6 Elastic Cement

Elastic cement shall be an approved brand of waterproof elastic slater's cement colored to match as nearly as possible the general color of the slate.

2.1.7 Acid Neutralizing Wash

****

NOTE: In areas of the country where past burning of fossil fuels has caused acid staining of slate roofs and existing portions of the roof are being reused or are to remain in place, application of an acid neutralizing wash is recommended. Edit specification to meet project requirements.

****

Acid neutralizing wash shall be non-destructive wash formulated to neutralize the effects of acid deposits resulting from the past burning of fossil fuels (particularly coal). The wash shall not change the color, appearance, or life of the slate roof, copper flashing and accessories, underlayment, adhesives or the wall surfaces of the building.

PART 3 EXECUTION

3.1 PROTECTION OF ROOF SURFACES

Equipment (such as padded ridge ladders) and techniques shall be used which prevent damage to roof as a result of foot or material traffic. Contractor shall be responsible for controlling breakage of new or existing slate beyond what is indicated. The progression of work shall be laid out and presented to the Contracting Officer to prevent other trades from working on or above completed roofing. Personnel who are working on the roof shall have proper shoes which will not further damage slates, and shoe soles shall be made of a material which will aid in preventing falls.

3.2 SLATE REMOVAL

Where work involves partial replacement or repair of roof, Contractor shall verify each slate for tightness and continued use. Testing shall be done with broad, flat-nosed, slater's pliers. Slates which have been identified for replacement or re-installation shall be marked for approval within 30 days after Notice to Proceed. Slates identified for removal shall be marked with a non-destructive color mark removable by solvent, rather than water. Slates fastened with non-copper fasteners shall be re-fastened with proper copper fasteners.

3.3 PREPARATION OF SURFACES

Roof deck surfaces shall be smooth, clean, firm, dry, and free from loose boards, large cracks, and projecting ends that might damage the roofing. Foreign particles shall be cleaned from interlocking areas to ensure proper seating and to prevent water damming. Prior to installation of slate, vents and other projections through roofs shall be properly flashed and secured in position, and projecting nails shall be driven firmly home.

3.4 ROOFING FELT

Felt shall be laid in horizontal layers with joints lapped toward eaves and at ends at least 2 inches, and secured along laps and at ends as necessary to hold the felt in place and protect the structure until covered with the slate. Felt shall be preserved unbroken, tight and whole. Felt shall lap hips and ridges at least 12 inches to form a double thickness and shall be lapped 2 inches over the metal of valleys or built-in gutters.

3.5 ELASTOMERIC MEMBRANE UNDERLAYMENT

****

NOTE: A composite self-adhering membrane will be used in areas where ice build-up (ice dams) and wind driven rains are potential problems. In such areas, underlayment installation will be detailed on the drawings. Edit these paragraphs to meet project requirements.

****

3.5.1 Surface Preparation

Dust, dirt, loose nails or other protrusions shall be removed. Priming is not required for wood or metal surfaces but is necessary on concrete or masonry surfaces.

3.5.2 Primer

Primer shall be applied at a coverage rate of 250-350 sq. ft./gal. Primer shall be applied by spray or paint roller. Pine wood decks shall be covered with minimum 1/4 inch plywood prior to receiving membrane coverage.

3.5.3 Temperature

Membrane shall be applied only in fair weather when air and surface temperatures are above 40 degrees F.

3.5.4 Membrane Application

Membrane shall be applied according to manufacturer's instructions. Membrane shall be adhered directly to roof deck. The membrane shall be cut into 10 to 15 foot lengths and shall be re-rolled. The release paper shall be peeled back 1 to 2 feet;the membrane shall be aligned on the lower edge of the roof and the first 1 to 2 feet shall be placed. The release paper under the membrane shall be peeled from the membrane. The membrane shall be pressed in place. Lower edges shall be rolled firmly with a wallpaper or hand roller. For ice dam protection, membrane shall be applied to reach a point above the highest expected level of ice dams; refer to drawings for extent. Ends and edges shall be overlapped a minimum of 6 inches. Membrane shall not be folded onto an exposed face of the roof edge.

3.5.5 Valley and Ridge Application

The membrane shall be cut into 4 to 6 footlengths. The release paper sheet shall be peeled and centered over the valley or ridge, then draped and pressed in place, working from the center of the valley or ridge outward in each direction. For valleys, membrane shall be applied starting at the low point and working upwards. All sheets shall be overlapped a minimum of 6 inches.

3.5.6   Vertical Membrane Flashings

Vertical wall installations shall receive primer prior to the application of membrane. Primer shall be applied at a coverage rate of 250-350 sq. ft./gal. Membrane shall be turned up walls and dormers as indicated on the drawings. Vertical membrane terminations shall be mechanically fastened. Vertical terminations shall receive a troweling of mastic as approved by the membrane manufacturer. Membrane may be folded onto the fascia, provided it will be covered by a gutter metal edge or other material.

3.5.7   Protection

Elastomeric membrane underlayment shall not be left permanently exposed to sunlight. Membrane shall be covered with exposed roofing materials as soon as possible. Membrane damaged due to exposure to sunlight shall be patched prior to the application of final roof covering.

3.6   METAL FLASHING

Metal flashing shall be as shown at intersections of vertical or projecting surfaces through the roof or against which the roof abuts, such as walls, parapets, dormers, and sides of chimneys. Flashing installation shall be in accordance with Section 07600 SHEET METALWORK, GENERAL.

3.7   SLATING

****

NOTE: The best guide to traditional slating installation procedures is "Slate Roofs", published in 1925 by the National Slate Association. A reprint was issued in 1977 by the Vermont Structural Slate Co. The Steep Roofing Section of the National Roofing Contractors Association Roofing Manual contains a section on Slate Roofing which is essentially an abridged and edited version of the original 1925 publication.

****

3.7.1   Repair and Replacement

Existing reusable slates removed from the repair area shall be intermingled with new slates to provide a smooth visual transition between new and existing areas. Slating shall be applied as shown.

3.7.2   Slate Coursing

The slate shall project 2 inches at the eaves and 1 inch at gable ends, and shall be laid in horizontal courses with 3 inch headlap (unless otherwise indicated), and each course shall break joints with the preceding one by at least 3 inches.Slates at the eaves or cornice line shall be doubled and canted 1/4 inch by a wooden cant strip, using same thickness slate for under-eaves at first exposed course. Under-eave slate shall be approximately 3 inches longer than exposure of first course. There shall be no through joints from the roof surface to the underlayment.

3.7.3   Nailing

Each slate shall be fastened with a minimum of two copper nails of sufficient length to penetrate the roof decking at least 3/4 inch or through the decking thickness, whichever is less. Where the underside of roof decking is exposed to view, such as in overhanging eaves, the nails shall be long enough to penetrate the roof decking but not so long that they may be driven through the decking. The heads of slating nails shall just touch the slate and shall not be driven "home" or draw the slate, but left with the heads just clearing the slate so that the slate hangs on the nail. Nails in slates overlapping sheet metalwork shall not puncture the sheet metal. Exposed nails are permissible only in top courses where unavoidable. Exposed nail heads shall be covered with elastic cement. Hip slates and ridge slates shall be laid in elastic cement spread thickly over unexposed surface of under courses of slate, nailed securely in place and pointed with elastic cement.

3.7.4 Vertical Surfaces

Slate shall be fitted neatly around pipes, ventilators, chimneys and other vertical surfaces.

3.7.5 Hips

Hips shall be laid to form a [fantail] [saddle] [mitered] [Boston] hip as shown.

3.7.6 Ridges

Ridges shall be laid to form [comb] [saddle] [strip saddle] ridges. The nails of the combing slate shall pass through the joints of the slate below. The combing slate shall be laid with the same exposure as the next course down. Combing slates sloping away from the direction of the prevailing storms shall project 1 inch above the combing slate on the opposite side of ridge.

3.7.7 Valleys

Valleys shall be laid to form [closed] [open] [round] valleys.

3.8 ACCESSORIES FOR SLATE ROOFS

3.8.1 Crickets or Saddles

Vertical surfaces which project through the roof surface at a right angle to the slope of the roof shall have a cricket (sometimes referred to as a saddle) built into the roof to divert water away from the back of the vertical member, as shown. Crickets of light rafter construction covered with sheathing, underlayment, and copper sheet metal specified in Section 07600 SHEET METALWORK, GENERAL. If the cricket area is large and exposed to view, it shall be slated the same as other roof areas. Open-type valleys shall be formed with the main roof at cricket areas. The size of the cricket is largely determined by the roof condition. Unless noted otherwise, the slope of the cricket shall be the same as the slope of the roof.

3.8.2 Snow Guards

****

NOTE: Snow guards are necessary accessories for

most slate roofs in sections of the country where masses of snow and ice accumulate on the roof that can slide from the roof onto lower roof surfaces and gutters. Snow guards are manufactured in various forms, and each type requires different methods of application. They may be obtained from slate distributors, quarriers of roofing slate, or manufacturers. Edit to meet project requirements.
****

Nonferrous metal show guards shall be provided as indicated.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-07311 (August 1998)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**
Superseding
CEGS-07311 (July 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

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-- End of Section Table of Contents --

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DEPARTMENT OF THE ARMY **CEGS-07311 (August 1998)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**
Superseding
CEGS-07311 (July 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 07311

ROOFING, STRIP SHINGLES
08/98

****
NOTE: This guide specification covers the requirements for asphalt strip shingles surfaced with mineral granules, including roofing felt and ridge vents. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: Drawings must show roof plan and applicable details. This guide specification does not include requirements for the following:

a. Deck treatment for reroofing work (with either old roofing to remain in place or old roofing to be removed). Removal of existing roof if there is more than one in place or the roof shows signs of curling, cupping or excessive mineral loss.

b. Mansard construction slopes of 1.75:1 or steeper.

c. Application of shingles on precast cementitious roof decks.

Requirements and recommendations on a. and b., above may be found in "Asphalt Shingle Roofing Manual" published by the National Roofing Contractors Assn. (NRCA), 10255 West Higgins Road, Suite 600, Rosemont, IL 60018-5607. For c. above, deck manufacturers should be consulted for their recommendations.

Algae growth on roof shingles is a problem in approximately 30 to 40% of the country; particularly, with humid conditions. Check with local shingle suppliers in the project area to determine if algae growth prevention is needed. The most popular method of algae prevention is to require algae-inhibiting zinc or copper granules be incorporated in the mineral granule roof surfacing. This system normally provides algae prevention for a period of 10 to 15 years. Algae can also be controlled by the usage of a zinc or copper strip, placed at or near the ridge and on the hips. Rainwater, passing over the zinc or copper, inhibits algae in the areas that it wets. The zinc or copper will not remove existing algae, but when placed on new roofs, the strips have been reported to inhibit algae for the life of the roofs. This system can be unsightly with certain color roofs and must be detailed on the drawings.

Ventilation should be required with a total net free ventilating area of not less than 1 to 150 of the area of the space ventilated. The total area is permitted to be reduced to 1 to 300, provided at least 50 percent and not more than 80 percent of the required ventilating area is provided by ventilators located in the upper portion of the ventilated space at least 914 mm (3 feet) above eave or cornice vents, with the balance of required ventilation provided by eave or cornice vents. As an alternative, the net free cross-ventilation area may be reduced to 1 to 300 when a vapor barrier having a transmission rate not exceeding 1 perm is located on warm side of the attic insulation.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 225	(1995) Asphalt Shingles (Organic Felt) Surfaced with Mineral Granules
ASTM D 226	(1997) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 1970	(1997) Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D 3018	(1990; R 1994) Class A Asphalt Shingles Surfaced With Mineral Granules
ASTM D 3161	(1995a) Wind-Resistance of Asphalt Shingles (Fan-Induced Method)
ASTM D 3462	(1997) Asphalt Shingles Made From Glass Felt and Surfaced with Mineral Granules
ASTM D 4869	(1988; R 1993) Asphalt-Saturated Organic Felt Shingle Underlayment Used in Roofing
ASTM E 108	(1996) Fire Tests of Roof Coverings

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA Asph Shing Roof Mnl	(1996) Asphalt Shingle Roofing Manual

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Roofing System; [_____].

Manufacturer's catalog data, description of underlayment, shingles, fasteners, ridge vents, and flashing. Manufacturer's instructions, annotated or supplemented by the Contractor to indicate configuration and method for installing the materials, and for waterproofing of joints where flashings change direction. The number, spacing and orientation of fasteners shall be specified.

SD-14 Samples

Finishes; GA.

Full shingle sample and manufacturer's standard size samples of materials and products requiring color or finish selection.

1.3   DELIVERY AND STORAGE OF MATERIALS

Materials shall be delivered in manufacturer's unopened bundles and containers with the manufacturer's brand and name marked clearly thereon. Shingles shall be stored in accordance with manufacturer's printed instructions. Roll goods shall be stored on end in an upright position or in accordance with manufacturer's recommendations. Immediately before laying, roofing felt shall be stored for 24 hours in an area maintained at a temperature not lower than 50 degrees F.

1.4   WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2   PRODUCTS

2.1   MATERIALS

Materials shall conform to the following requirements:

2.1.1   Metal Drip Edges

Metal drip edges shall be minimum 26 gauge galvanized steel or an equivalent non-corrosive non-staining material, as shown.

2.1.2   Underlayment

Organic felt; ASTM D 4869 or ASTM D 226, non perforated [Type I, number 15] [Type II, heavy-duty number 30].

2.1.3   Leak Barrier Underlayment

Self-adhering leak barrier or ice dam underlayment shall comply with ASTM D 1970 for sealability around nails.

2.1.4   Ventilators

****

NOTE: Aluminum ridge vents can become scratched and/or dented with age. Drawings should detail type of ridge vent required.

****

2.1.4.1   Aluminum Ridge Vents

Ridge vents shall be constructed of prefinished aluminum in minimum 10 foot long sections and shall be approximately 1 foot wide. Vents shall be designed to prevent infiltration of insects, rain, and snow.

2.1.4.2 Nailable Plastic Shingle Over Type Ridge Vents

Ridge vents shall be constructed of UV stabilized nailable rigid polypropylene material, approximately 1 foot wide and 1 inch thick, and shall be in 4 foot long interlocking sections with self-aligning ends or corrugated polyethylene rigid roll or rigid strip ridge vent with aluminum wind deflectors on each side. Vents shall be designed to prevent infiltration of insects, rain, and snow.

2.1.4.3 Nailable Mesh Shingle Over Type Ridge Vents

Ridge vents shall be constructed of UV stabilized nailable polyester mesh material, approximately one foot wide. Vents shall be designed to prevent infiltration of insects, rain, and snow.

2.1.5 Nails

Nails shall be round head 11 or 12 gauge galvanized steel or equivalent corrosion resistant roofing nails. Nail heads shall be 3/8 inch minimum diameter, with flat and smooth low profile. Shanks shall be barbed or otherwise deformed for added pull-out resistance. Nails shall be long enough to penetrate all layers of roofing materials and achieve secure anchorage into the roof deck. Nails shall extend through the underside of plywood or wood panel roof decks, and shall penetrate at least 3/4 inch into wood plank decks.

2.1.6 Shingles

****

NOTE: For structures located adjacent to Air Force Facilities, high light reflectance colors should not be used where resultant glare would be objectionable to pilots.

Edit this paragraph for the correct weight of shingle required for the project. Heavyweight inorganic mat type shingles will be used for ARHOC 81 Barracks or similar designs for permanent construction which utilize shingles. Omit algae resistance if not required.

Hip and ridge shingles may be made from the strip shingle tabs or may be of a separate design. Generally, hip and ridge shingles cut from self-sealing individual full shingle tabs perform best.

****

Shingles shall be approximately [12 by 36] [_____] inches in dimension and [three-tab strip] [architectural] design. Shingles shall have self-sealing adhesive strips and shall meet a wind velocity rating of 60 mph plus or minus 5 percent in accordance with ASTM D 3161. [Shingles shall be [manufacturer's standard type for project area] [algae resistant].] [Organic shingles shall comply with ASTM D 225 Type I (uniform or non-uniform thickness) and ASTM E 108 Class C (a high degree of fire protection), and shall weigh not less than [210 lbs] [255 lbs.] [_____].] [Glass felt shingles shall comply with ASTM D 3018 and ASTM D 3462 Type I (self-sealing), ASTM E 108 Class A (a light degree of fire protection), and shall weigh not less than [190 lbs.] [240 lbs.] [_____].] Shingles shall be installed on the following buildings: [_____].

2.2   COLOR

Shingle color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

PART 3   EXECUTION

3.1   PREPARATION OF SURFACES

The construction of any bay or section of roof decking shall be completed before roofing work is started. Roof surfaces shall be smooth, firm, dry, and free from loose boards, large cracks, and projecting ends that might damage the roofing. Vents and other projections through roofs shall be properly flashed and secured in position, and projecting nails shall be driven flush with the deck.

3.2   APPLICATION OF ROOFING MATERIALS

3.2.1   Flashings

Metal flashings shall conform to Section 07600 SHEET METALWORK, GENERAL. Metal flashings shall be provided at the intersections of roofs and adjoining walls and at projections through the deck such as chimneys and vent stacks. Valley flashing shall be of the [open] [closed cut] [or] [woven type], in accordance with NRCA Asph Shing Roof Mnl.

3.2.2   Metal Drip Edges

Metal drip edges shall be provided along the eaves and rakes. The metal drip edge shall be applied directly over the underlayment along the rakes and directly on the wood deck at the eaves. Metal drip edges shall extend back from the edge of the deck not less than 3 inches and shall be secured with compatible nails spaced not more than 10 inches on center along the inner edge.

3.2.3   Underlayment

****

NOTE: A single layer of underlayment is required for all roof slopes greater than 1:3. A double layer of underlayment is required for roof slopes 1:6 thru 1:3.

Minimum slope of roofs on which shingles are permitted in other than cold climates is 1:6. For projects in locations where the January daily average temperature is minus 4 degrees C (25 degrees F) or less, roof slopes will be a minimum of 1:3 and underlayment requirements will be modified for ice dam protection.

The installation of asphalt strip shingles at maximum exposure is not recommended on roofs having a slope of less than 1:4.

In locations where the January mean temperature is minus one degree C (30 degrees F) or less, a leak barrier underlayment membrane should be used. The leak barrier underlayment membrane may consist of: two plies of No. 15 asphalt saturated felt, one nailed to the deck and the second set in Type III or Type IV hot asphalt or asphalt lap cement; a heavyweight coated base sheet nailed to the deck and another felt ply or plysheet set in hot asphalt or asphalt lap cement; or a self adhering modified bitumen membrane.

****

Before any shingles are applied, [a single layer] [two layers] of asphalt-saturated-felt underlayment shall be applied to the roof deck sheathing. In areas subject to ice damming, two plies of organic felt set in hot asphalt or asphalt lap cement, or an adhered polymer modified bitumen membrane underlayment shall be applied starting from the eaves to a point 24 inches inside the interior wall line.

3.2.4 Ridge Vents

Ridge vents shall be provided along the ridge lines where shown. Ridge vents shall be installed in accordance with the manufacturer's printed instructions.

3.2.5 Shingles

Shingles with the correct recommended exposure shall be applied in accordance with the manufacturer's printed instructions as they appear on the bundle wrapping.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-07320 (February 1995)**
U.S. ARMY CORPS OF ENGINEERS **--------------------------**

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 07320

CLAY TILE ROOFING
02/95

****
NOTE: This guide specification covers the requirements for clay tile roofing on new construction and on historic buildings which require replacement, reinstallation, or repair of clay tile roofs. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic

designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 370	(1992) Copper Sheet and Strip for Building Construction
ASTM C 1167	(1994a) Clay Roof Tiles
ASTM C 1184	(1995) Structural Silicone-Sealants
ASTM D 146	(1990) Sampling and Testing Bitumen-Saturated Felts and Fabrics Used in Roofing and Waterproofing
ASTM D 226	(1994) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 412	(1992) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 2822	(1991) Asphalt Roof Cement

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA-02	(1996) NRCA Roofing and Waterproofing Manual

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA-02	(1993) Architectural Sheet Metal Manual

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Clay Tile Roof System; [_____].

Manufacturer's catalog data and installation instructions.

SD-04 Drawings

Clay Tile Roof System; [_____].

Drawings showing clay tile installation and appearance details, flashing details, and fastening details for the tiles.

SD-08 Statements

Qualifications; [_____].

Documentation showing qualifications of personnel proposed to perform the roofing work, and a listing identifying prior installations completed by the Contractor.

SD-13 Certificates

Certificates of Compliance; [_____].

Certificates of compliance attesting that the materials meet specification requirements.

SD-14 Samples

Clay Roofing Tiles; [_____].

One representative tile of each type.

Sealants; [_____].

8 ounces of each type.

Underlayment Sheet; [_____].

1 by 1 foot section of each type.

Fasteners; [_____].

Representative samples of each fastener with identifying tags.

1.3 QUALIFICATIONS

The Contractor shall provide qualified workers, trained and experienced in installing clay tile roofing systems of this configuration, and shall submit documentation of 5 consecutive years of work of this type. The Contractor shall be familiar with and shall perform work in accordance with [SMACNA-02] [NRCA-02]. A list of installations shall be provided which identifies when, where, and for whom the installations were made.

1.4 DELIVERY, STORAGE AND HANDLING

Materials shall be delivered in manufacturer's unopened bundles and containers with the manufacturer's brand and name marked clearly thereon. Tiles shall be stored in accordance with manufacturer's printed instructions. Roll goods shall be stored on end in an upright position. Immediately before laying, roofing felt shall be stored for 24 hours in an area maintained at a temperature not lower than 50 degrees F.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Environmental Requirements

Clay tile roofing work shall proceed when existing and forecasted weather conditions permit work to be performed in accordance with manufacturer's recommendations and warranty requirements.

1.5.2 Material Storage

Materials shall not be stored on roof decks in such a manner as to overstress and/or damage the deck and supporting structure. Placing of loads at midspans of framing shall be avoided. Superimposed loads shall be well distributed.

1.5.3 Units of Work

Units of work shall be established, including removal of existing materials, preparation of existing surfaces and application of underlayment and nailers, and related temporary and/or permanent flashing so that it can be completed prior to the end of each working day.

1.5.4 Temporary Protection Materials

Materials shall be provided and maintained on the site at all times for temporary roofing, flashing, and other protection when delays and/or changed weather conditions do not permit completion of each unit of work prior to the end of each working day. Materials which have been used for temporary roofing, flashing and other protection shall be removed and discarded.

1.6 WARRANTY

A warranty shall be furnished against defects in material and workmanship of clay tile roof assembly, including related metal flashing for a period of 10 years from date of final acceptance of the work.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Edit these paragraphs to meet project requirements.

****

2.1.1 Existing Clay Tile

Intact and serviceable existing clay tiles shall be salvaged and reused whenever possible. New clay tiles being incorporated into existing clay tile roofs shall match existing as closely as possible. Clay tiles from the same manufacturer as the original shall be used if possible.

2.1.2 Clay Roofing Tile

Clay roofing tile shall be minimum Grade 1 tile conforming to ASTM C 1167. Tile shall be [one-piece barrel] [two-piece barrel] [flat shingle] [interlocking shingle] type in the following pattern: [_____]. Tile shall be [glazed] [unglazed].

2.1.2.1 Colors

Clay tile color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

2.1.2.2 Fittings

Clay tile fittings shall be of the following types as required by manufacturer's instructions: eave - [eave closure] [under eave]; gable - [end band] [gable rake]; ridge - [ridge] [closed ridge end] [ridge/hip terminal]; hip - [cut hip] [hip roll] [hip starter] [ridge/hip terminal]; valley - [cut valley] [closed valley].

2.1.3 Membrane

An underlayment membrane shall be furnished on surfaces to be covered with tile. Membrane shall consist of [asphalt-saturated felt] [and] [high strength composite self-adhering membrane].

2.1.3.1 Roofing Felt

Roofing felt shall be asphalt-saturated rag felt, Type II, No. 30 asphalt felt in accordance with ASTM D 226.

2.1.3.2 Elastomeric Membrane Underlayment

Elastomeric membrane shall be a cold applied composite self-adhering membrane, minimum 0.004 inch thick, high strength polyethylene film with slip resistant embossing, coated on one side with a thick layer of adhesive-consistency rubberized asphalt, interwound with a disposable silicone coated release sheet. The tensile strength and elongation values shall be not less than 250 psi when tested in accordance with ASTM D 412 and pliability shall be unaffected when tested in accordance with ASTM D 146.

2.1.3.3 Elastomeric Membrane Accessories

Two component urethane, mastic and primer shall be as approved by the membrane manufacturer. Flashing, expansion joint covers, temporary UV protection and corner fillets shall be as recommended by the membrane manufacturer.

2.1.4 Fasteners

2.1.4.1 Nails

Nails shall be solid copper, Number 11 gauge nails, minimum 5/16 inch head. Nails shall be of sufficient length to adequately penetrate the roof sheathing.

2.1.4.2 Miscellaneous Fasteners

Miscellaneous fasteners may include but are not limited to: wind locks, hurricane clips, tile attachment brackets, tile nails, twisted wire (tile-tie), deck anchor systems, and flashing cleats. Fasteners shall be made of solid copper (wind locks and hurricane clips can be made of stainless steel).

2.1.5 Flashing

Flashing shall be 20 ounce, light cold-rolled temper (H00) copper conforming to ASTM B 370. Like metals shall be used on all components of fastening systems and flashing in order to avoid galvanic action. Flashing shall be in accordance with the requirements as specified in Section 07600 SHEET METALWORK, GENERAL.

2.1.6 Plastic Cement

Plastic cement for gable rakes, hip rolls, ridges, stringers and other conditions shall be non-running, heavy body plastic cement composed of ingredients complying with ASTM D 2822.

2.1.7 Sealant

Sealant, when used in lieu of plastic cement, shall be silicone in accordance with ASTM C 1184.

2.1.8 Mortar

Mortar for filling the openings of cut valley tiles shall consist of 1 part portland cement to 3 parts damp plaster sand, and shall be colored to the nearest possible match with the color of the tile.

2.1.9 Wood Strips

Wood strips for nailers, battens, cant strips, and eave strips shall be of foundation grade redwood or preservative treated Douglas fir. Sizes and lengths shall be provided per tile manufacturer's installation details.

2.1.10 Snow Guards

****

NOTE: Snow guards are necessary accessories for most tile roofs in sections of the country where masses of snow and ice accumulate on the roof that can slide from the roof onto lower roof surfaces and gutters. Snow guards are manufactured in various forms, and each type requires different methods of application. Edit to omit this paragraph if not necessary to meet project requirements.

****

Snow guards which are compatible with the roof tile shall be provided as indicated.

PART 3 EXECUTION

3.1 PROTECTION OF ROOF SURFACES

Equipment (such as padded ridge ladders) and techniques shall be used which prevent damage to roof as a result of foot or material traffic. Contractor shall be responsible for controlling breakage of new or existing tile beyond what is indicated. The progression of work shall be laid out and presented to the Contracting Officer to prevent other trades from working on or above completed roofing. Personnel who are working on the roof shall have proper shoes which will not further damage tiles and shoe soles shall be made of a material which will aid in preventing falls.

3.2 TILE REMOVAL

Where work involves partial replacement or repair of roof, Contractor shall verify each tile for tightness and continued use. Tiles which have been identified for replacement or re-installation shall be marked for approval within 30 days of Notice to Proceed. Tiles identified for removal shall be marked with a non-destructive color mark which can be easily removed. Tiles fastened with non-copper fasteners shall be re-fastened with proper copper fasteners.

3.3 PREPARATION OF SURFACES

Roof deck surfaces shall be smooth, clean, firm, dry, and free from loose boards, large cracks, and projecting ends that might damage the roofing. Foreign particles shall be cleaned from all interlocking areas to ensure proper seating and to prevent water damming. Prior to installation of tile, vents and other projections through roofs shall be properly flashed and secured in position, and projecting nails shall be driven firmly home.

3.4 ROOFING FELT

3.4.1 Standard Application

Felt shall be laid in horizontal layers on deck areas to be covered with tile. Two layers of No. 30 felt shall be applied. Applications shall be doubled on rough surfaces and overlapped 12 inches on hips, valleys, and ridges. Joints shall be lapped 2-1/2 incheshorizontally and 6 inches vertically. Felt shall be carried 6 inches up vertical surfaces and 4 inchesover gutter and valley metal. Edges shall be fastened with corrosion-resistant, 12 gauge, 3/8 inch head standard roofing nails on 6 inch centers. Felt shall be preserved unbroken, tight and whole.

3.4.2 Special Applications

Low pitch roofs shall have two layers of felt installed and shall be solidly mopped between felt layers and on top of felt layers with 25 pounds per square of hot asphalt.

3.5 ELASTOMERIC MEMBRANE UNDERLAYMENT

****

NOTE: A composite self-adhering membrane will be used in areas where ice build-up (ice dams) and wind driven rains are potential problems. In such areas, underlayment installation will be detailed on the drawings. Edit these paragraphs to meet project requirements.

****

3.5.1 Surface Preparation

Dust, dirt, loose nails or other protrusions shall be removed. Priming is not required for wood or metal surfaces but is necessary on concrete or masonry surfaces.

3.5.2 Primer

Primer shall be applied at a coverage rate of 250-350 sq. ft./gal. Primer shall be applied by spray or paint roller.

3.5.3 Temperature

Membrane shall be applied only in fair weather when air and surface temperatures are above 40 degrees F.

3.5.4 Membrane Application

Membrane shall be applied according to manufacturer's instructions. Membrane shall be adhered directly to roof deck. Pine wood decks shall be covered with minimum 1/4 inch plywood prior to receiving membrane coverage. Membrane shall be cut into 10 to 15 foot lengths and shall be re-rolled. The release paper shall be peeled back 1 to 2 feet and the membrane shall be aligned on the lower edge of the roof and the first 1 to 2 feet shall be placed. The release paper under the membrane shall be pulled and peeled from the membrane. The membrane shall be pressed in place. Lower edges shall be rolled firmly with a wallpaper or hand roller. For ice dam protection, membrane shall be applied to reach a point above the highest expected level of ice dams. Ends and edges shall be overlapped a minimum of 6 inches. Membrane shall not be folded onto an exposed face of the roof edge.

3.5.5 Valley and Ridge Application

The membrane shall be cut into 4 to 6 footlengths. The release paper shall be peeled and the sheet centered over the valley or ridge, draped and pressed in place working from the center of the valley or ridge outward in each direction. For valleys, membrane shall be applied starting at the low point and working upwards. Sheets shall overlap a minimum of 6 inches.

3.5.6 Vertical Membrane Flashings

Vertical wall installations shall receive primer prior to the application of membrane. Primer shall be applied at a coverage rate of 250-350 sq. ft./gal. Membrane shall be turned up walls and dormers as indicated on the drawings. Vertical membrane terminations shall be mechanically fastened. Vertical terminations shall receive a troweling of mastic as approved by the membrane manufacturer. Membrane may be folded onto the fascia, provided it will be covered by a gutter metal edge or other material.

3.5.7 Protection

Elastomeric membrane underlayment shall not be left permanently exposed to sunlight. Membrane shall be covered with exposed roofing materials as soon as possible. Membrane damaged due to exposure to sunlight shall be patched prior to the application of final roof covering.

3.6 METAL FLASHING

Metal flashing shall be as shown at intersections of vertical or projecting surfaces through the roof or against which the roof abuts, such as walls, parapets, dormers, and sides of chimneys. Flashing installation shall be in accordance with Section 07600 SHEET METALWORK, GENERAL.

3.7 CLAY ROOFING TILE (GENERAL)

****

NOTE: To ensure a watertight roof system, strict observance of minimum pitch requirement is necessary. Minimum roof pitches for the different types of clay tile shall be: one-piece barrel: 4:12; two-piece barrel: 5:12; flat shingle: 5:12; interlocking shingle: 3:12.

****

3.7.1 Repair and Replacement

Existing reusable clay tiles removed from the repair area shall be intermingled with new clay tiles to provide a smooth visual transition between new and existing areas.

3.7.2 High or Low Slope Pitches

Tiles [on roof slopes of less than 3:12 shall be applied over indicated underlayment on solid decking.] [on extremely steep or vertical applications, shall have the butt of each tile set with mastic or sealant, and placed where it will not be seen. The mastic or sealant shall not stain the surface of the tile. Copper "hurricane clips" may be installed instead of using mastic or sealant.]

3.7.3 Roof Decks and Fasteners

Tile shall be fastened to roof deck materials as follows:

DECK	FASTENER
Plywood	Slater's ring shank nail. Point shall just penetrate through underside of deck.
Plank board, 1 inch or more in thickness	Slater's plain shank nail, at least 1-1/2 inch shall not penetrate deck.
Gypsum plank or Nailable Concrete	Stainless steel or silicone bronze nails with spiral threads, 1-1/2 or 2 inch long. Nail shall penetrate deck at least 1/2 its thickness, but no more than 3/4. Underside of deck shall not be penetrated. If deck material is old and excessively hard, smooth shank nails shall be used.
Metal	Sheet metal screw and mastic
Fibrous cement	Tile-tie system

Note: All fastening and flashing metals shall be of like material in order to avoid galvanic action.

3.7.4 Poured Concrete Deck

Poured concrete decks shall have embedded 1 by 2 inchbeveled wood strips, extending from eave to ridge, spaced 20 inches on centers. Concrete shall be smooth and flush with strips. Felts weighing 50 lbs. per 100 square feetshall be fastened with lath nailed over embedded strips. One by 2 inch wood strips, spaced to suit tile, shall be applied horizontally across lath. Tile shall then be laid as directed for a sheathed roof.

3.7.5 Chalk Lines

Horizontal and vertical guide lines shall be chalked on the membrane to assure proper appearance. The chalk lines shall be spaced by measuring the delivered tiles for average length and width exposures. An exposure length of 1/4 inch beyond the average shall not be exceeded.

3.8 ONE-PIECE BARREL TILE APPLICATION

3.8.1 Wood Strips

Wood stringers, 1 inch wide and of proper height, shall be applied on hips and ridges to carry hip roll and ridge. A 1 by 2 inch strip shall be applied for end bands. A 1 by 2 inch cant strip shall be applied at eaves if eave closures are not specified.

3.8.2 Tile Application

a. Eave closures shall be installed first.

b. Tiles shall be laid to straight lines parallel to ground level and shall be lapped 3 inches vertically.

c. Each tile shall be fastened with 1, 2, or 3 nails as required in each tile or fitting. Nails shall not be driven so far as to produce a strain on the tile, nor left proud to stress overlapping tile.

d. Nails on tiles overlapping sheet metalwork shall not puncture the sheet metal. Tiles overlapping sheet metal shall be fastened with copper wire and plastic cement.

e. Gable rakes shall be cemented to field tiles and fastened with nails.

f. Hip rolls shall be cemented in laps and fastened with 2 inch copper nails.

g. Ridges shall be cemented and fastened with 2-1/2 inchcopper nails in laps and where they rest on roof tiles.

h. Where tiles join hip stringers they shall be made waterproof with flashing cement.

i. When hip starter and closed ridge end fittings have not been specified, the voids at ends of hips and ridges shall be filled with mortar colored to nearest match of tile color.

j. Tile in contact with cement mortar shall be immersed in water for at least 2 minutes before laying.

k. When ridge angles and hip/ridge terminals are not otherwise specified, they shall be mitered on job, nailed or wired, and set in plastic cement.

l. When short course tiles are not otherwise specified for rafters which do not accommodate full courses, they shall be cut and drilled on job by roofer unless a plus or minus 1 inch adjustment of regular tile overhang at eave is sufficient.

3.9 TWO-PIECE BARREL TILE APPLICATION

3.9.1 Wood Strips

Wood stringers, 1 inch wide and of proper height, shall be applied on hips and ridges to carry hip roll and ridge. A 1 by 3-1/2 inch strip shall be applied and spaced appropriately for covers. When covers are laid at random exposure, strips shall be 1 by 4 inches. At first row of cover tile after gable roll, a regular nailing strip shall be applied with an adjacent 2 by 2 inch nailing strip along rake side. A 1 by 2 inch cant strip shall be applied at eaves if eave closures are not specified.

3.9.2 Tile Application

a. Eave closures shall be installed first.

b. Tiles shall be laid to straight lines parallel to ground level, and shall be lapped 3 inches vertically.

c. Each tile shall be fastened with 1, 2, or 3 nails as required in each tile or fitting. Nails shall not be driven so far as to produce a strain on the tile, nor left proud to stress overlapping tile.

d. Tiles overlapping sheet metalwork shall have the nails so placed as to avoid puncturing the sheet metal. Tiles overlapping sheet metal shall be fastened with copper wire and plastic cement.

e. When tile is applied tight method, short course covers shall be installed over regular pans at eave and regular covers over short course pans at ridge. Top edge of covers shall abut bottom edge of pans in the succeeding course throughout the roof.

f. When covers are laid at random exposure, 10 percent extra covers in the first three courses at eave shall be used to avoid horizontal and diagonal lines and maintain this effect throughout roof.

g. Gable rakes shall be cemented to field tiles and fastened with nails.

h. Hip rolls shall be cemented in laps and fastened with 2 inch copper nails.

i. Ridges shall be cemented and fastened with 2-1/2 inchcopper nails in laps and where they rest on roof tiles.

j. Where tiles join hip stringers they shall be made waterproof with flashing cement.

k. When hip starter and closed ridge end fittings have not been specified, the voids at ends of hips and ridges shall be filled with mortar colored to nearest match of tile color.

l. Tile in contact with cement mortar shall be immersed in water for at least 2 minutes before laying.

m. When ridge angles and hip/ridge terminals have not been specified, they shall be mitered on job, nailed or wired, and set in plastic cement.

n. When short course tiles are not otherwise specified for rafters which do not accommodate full courses, they shall be cut and drilled on job by roofer unless a plus or minus 1 inch adjustment of regular tile overhang at eave is sufficient.

3.10 FLAT SHINGLE TILE APPLICATION

3.10.1 Wood Strips

Wood stringers, 1 inch wide and of proper height, shall be applied on hips and ridges to carry hip roll and ridge. A 3/4 by 1 inch cant strip shall be applied at eaves.

3.10.2 Tile Application

a. Tiles shall be laid to straight lines parallel to ground level, lapped 3 inch vertically.

b. Each tile shall be fastened with 1, 2, or 3 nails as required in each tile or fitting. Nails shall not be driven so far as to produce a strain on the tile, nor left proud to stress overlapping tile.

c. Nails on tiles overlapping sheet metalwork shall not puncture the sheet metal. Tiles overlapping sheet metal shall be fastened with copper wire and plastic cement.

d. Gable rakes shall be cemented to field tiles and fastened with nails.

e. Hip rolls shall be cemented in laps and fastened with 2 inch copper nails.

f. Ridges shall be cemented and fastened with 2-1/2 inchcopper nails in laps and where they rest on roof tiles.

g. Where tiles join hip stringers they shall be made waterproof with flashing cement.

h. Voids at ends of hips and ridges shall be filled with mortar colored to nearest match of tile color.

i. Tile in contact with cement mortar shall be immersed in water for at least 2 minutes before laying.

j. Ridge angles and hip/ridge terminals shall be mitered on job, nailed or wired, and set in plastic cement.

k. When short course tiles are not otherwise specified for rafters which do not accommodate full courses, they shall be cut and drilled on job by roofer unless a plus or minus 1 inch adjustment of regular tile overhang at eave is sufficient.

3.11 INTERLOCKING SHINGLE TILE APPLICATION

3.11.1 Wood Strips

Wood stringers, 1 inch wide and of proper height, shall be applied on hips and ridges to carry hip roll and ridge. A 7/8 by 1 inch cant strip shall be applied at eaves.

3.11.2 Tile Application

a. Tiles shall be laid to straight lines parallel to ground level, lapped 3 inches vertically.

b. Each tile shall be fastened with 1, 2, or 3 nails as required in each tile or fitting. Nails shall not be driven so far as to produce a strain on the tile, nor left proud to stress overlapping tile.

c. Nails on tiles overlapping sheet metalwork shall not puncture the sheet metal. Tiles overlapping sheet metal shall be fastened with copper wire and plastic cement.

d. Gable rakes shall be cemented to field tiles and fastened with nails.

e. Hip rolls shall be cemented and fastened with 2 inchcopper nails in laps.

f. Ridges shall be cemented and fastened with 2-1/2 inchcopper nails in laps and where they rest on roof tiles.

g. Where tiles join hip stringers they shall be made waterproof with flashing cement.

h. Voids at ends of hips and ridges shall be filled with mortar colored to nearest match of tile color.

i. Tile in contact with cement mortar shall be immersed in water for at least 2 minutes before laying.

j. Ridge angles and hip/ridge terminals shall be mitered on job, nailed or wired, and set in plastic cement.

k. When short course tiles are not otherwise specified for rafters which do not accommodate full courses, they shall be cut and drilled on job by roofer unless a plus or minus 1 inch adjustment of regular tile overhang at eave is sufficient.

-- End of Section --

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS

CEGS-07412 (October 1998)

Superseding
CEGS-07412 (July 1997)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 2 (September 1999)

Latest change indicated by CHG tags

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NON-STRUCTURAL METAL ROOFING

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DEPARTMENT OF THE ARMY **CEGS-07412 (October 1998)**
U.S. ARMY CORPS OF ENGINEERS **-------------------------**
Superseding
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GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 2 (September 1999)

Latest change indicated by CHG tags
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SECTION 07412

NON-STRUCTURAL METAL ROOFING
10/98

****
NOTE: This guide specification covers the requirements for both factory color and mill finish Non-Structural Metal Roofing. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: This guide specification will be used in the preparation of project specifications for non-structural metal roofing (sometimes referred to as architectural metal roofing) applied to a solid substrate (roof deck) with an appropriate underlayment.

Non-structural metal roofing is a system of metal roof panels normally installed on slopes greater than 2 in 12 over an appropriate waterproof underlayment attached directly to a solid substrate

with hidden anchor clips, generally spaced at 300 to 450 mm (12 to 18 inches) on center along the seams. Inward and outward imposed loads are transferred to, and resisted by, the substrate. These panels are limited to widths no greater than 400 mm (16 inches). The panels are not capable of spanning between structural supports without benefit of substrate materials such as wood, metal, or concrete decks. The panels serve primarily as an aesthetic water shedding covering, like shingles, and should not be thought of as a waterproof membrane. Requirements for the substrates are not included in this specification.

Metal roofing manufacturers offer a variety of different profiles for non-structural metal roofing with vertical side laps or standing seams. Some of the more common industry terms for the side laps are: "Snap-Seam," "Snap-Lok," "Lok-Seam," "Batten-Seam," "Snap-Batten Seam". All are attached directly or by hidden anchor clips fastened to a solid substrate such as plywood or metal decking. There are a limited number of manufacturers that still provide a non-structural metal roofing panel with exposed fasteners; however, the hidden clip fastener is the most common.
****

1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 463/A 463M	(1997) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 653/A 653M	(1998) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 792/A 792M	(1997) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B 209M	(1995) Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C 518	(1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation
ASTM C 991	(1998) Flexible Glass Fiber Insulation for Pre-Engineered Metal Buildings
ASTM C 1177/C 1177M	(1996) Glass Mat Gypsum Substrate for Use as Sheathing
ASTM C 1289	(1998) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D 226	(1997a) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 522	(1993a) Mandrel Bend Test of Attached Organic Coatings
ASTM D 523	(1989; R 1994) Specular Gloss
ASTM D 610	(1995) Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D 714	(1987; R 1994) Evaluating Degree of Blistering of Paints
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 1308	(1987; R 1998) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2244	(1995) Calculation of Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	(1997) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	(1993) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM D 4214	(1998) Evaluating Degree of Chalking of Exterior Paint Films

ASTM D 4397	(1996) Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 4587	(1991) Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light- and Water- Exposure Apparatus
ASTM D 5894	(1996) Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet
ASTM E 84	(1998e1) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials

UNDERWRITERS LABORATORIES (UL)

UL 580	(1994; Rev thru Feb 1998) Tests for Uplift Resistance of Roof Assemblies

1.2 GENERAL REQUIREMENTS

The Contractor shall furnish a commercially available roofing system which satisfies the specified design and additional requirements contained herein. The roofing system shall be provided by the Contractor as a complete system, as tested and approved in accordance with UL 580. Roof panels, components, transitions, accessories, and assemblies shall be supplied by the same roofing system manufacturer.

1.2.1 Non-Structural Metal Roof System

The Non-Structural Metal Roof System covered under this specification shall include the entire roofing system; the metal roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with UL 580. The system shall be installed on a substrate specified in Section [_____]. In addition, the system shall consist of panel finishes, slip sheet, insulation, vapor retarder, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, curbs, skylights; interior or exterior gutters and downspouts, eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system; and items specified in other sections of the specifications that are part of the system.

1.2.2 Manufacturer

The non-structural metal roofing system shall be the product of a manufacturer who has been in the practice of manufacturing metal roofs for a period of not less than 3 years and has been involved in at least five projects similar in size and complexity to this project.

1.2.3 Installer

The installer shall be certified by the metal roof manufacturer to have experience in installing at least three projects that are of comparable size, scope and complexity as this project for the particular roof system furnished. The installer may be either employed by the manufacturer or be an independent installer.

1.3 DESIGN LOADS

****

NOTE: Design loads will be in accordance with ASCE 7 or TI 809-01; wind uplift pressures will be shown on the contract drawings.

****

Non-structural Metal Roof System assemblies shall be tested as defined in UL 580 and shall be capable of resisting the wind uplift pressures shown on the contract drawings or, as a minimum, shall be approved to resist wind uplift pressures of UL 580, Class 90.

1.4 PERFORMANCE REQUIREMENTS

****

NOTE: The roof slope will be indicated on the contract drawings. Metal roofs must be designed to accommodate effects of ice damming and other conditions in cold climates. See TI 809-29 for guidance.

Since this is a performance specification and a wide variety in roof system configurations, fastening systems, and accessories are available, generic details of valley, expansion joints, flashing, underlayments, roof penetrations, curbs, eaves, ridges, intersection and other unique situations of the roof system will be shown on the contract drawings.

****

The metal roofing system supplied shall conform to the roof slope, the underlayment, and uplift pressures shown on the contract drawings. The Contractor shall furnish a commercially available roofing system which satisfies all the specified requirements.

1.5 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government

approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Metal Roofing; GA.

a. Drawings consisting of catalog cuts, flashing details, erection drawings, shop coating and finishing specifications, and other data as necessary to clearly describe materials, sizes, layouts, construction details, fasteners, and erection. Drawings shall be provided by the metal roofing manufacturer.

b. Drawings showing the UL 580, Class 90 tested roof system assembly.

SD-13 Certificates

Roof Panels; [_____]. Installation; [_____]. Accessories; [_____].

Certificates attesting that the panels and accessories conform to the specified requirements. Certificate for the roof assembly shall certify that the assembly complies with the material and fabrication requirements specified and is suitable for the installation at the indicated design slope. Certified laboratory test reports showing that the sheets to be furnished are produced under a continuing quality control program and that at least 3 representative samples of similar material to that which will be provided on this project have been previously tested and have met the quality standards specified for factory color finish.

Insulation; [_____].

Certificate attesting that the polyurethane or polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

Installer; [_____].

Certification of installer.

Warranties; [_____].

At the completion of the project, signed copies of the 5-year Warranty for Non-Structural Metal Roofing System, a sample copy of which is attached to this section, and the 20-year Manufacturer's Material [and Weathertightness] Warranties.

SD-14 Samples

Accessories; [_____].

One sample of each type of flashing, trim, fascia, closure, cap and similar items. Size shall be sufficient to show construction and configuration.

Roof Panels; [_____].

One piece of each type and finish to be used, 9 inches long, full width.

Fasteners; [_____].

Two samples of each type to be used with statement regarding intended use. If so requested, random samples of screws, bolts, nuts, and washers as delivered to the jobsite shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

Gaskets and Insulating Compounds; [_____].

Two samples of each type to be used and descriptive data.

Sealant; [_____].

One sample, approximately 1 pound, and descriptive data.

1.6 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials shall be covered with weather tight coverings and kept dry. Material shall not be covered with plastic where such covering will allow sweating and condensation. Plastic may be used as tenting with air circulation allowed. Storage conditions shall provide good air circulation and protection from surface staining.

1.7 WARRANTIES

The Non-Structural Metal Roofing System shall be warranted as outlined below. Any emergency temporary repairs conducted by the owner shall not negate the warranties.

1.7.1 Contractor's Weathertightness Warranty

The Non-Structural Metal Roofing System shall be warranted by the Contractor on a no penal sum basis for a period of five years against material and workmanship deficiencies; system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks, and wind uplift damage. The roofing covered under this warranty shall include the entire roofing system, including but not limited to, the roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with UL 580. In addition, the system shall consist of panel finishes, slip sheet, insulation, vapor retarder, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, curbs, skylights; interior or exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system; and items specified in other sections of the specifications that are part of the roof system. All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate resistance to service design loads, water leaks and wind uplift damage shall be repaired as approved by the Contracting Officer. See the attached Contractor's required warranty for issue resolution of warrantable defects. This warranty shall warrant and cover the entire cost of repair or replacement, including all material, labor, and related markups. The Contractor shall supplement this warranty with written warranties from the installer and system manufacturer, which shall be submitted along with Contractor's warranty; however, the Contractor shall be ultimately responsible for this warranty. The Contractor's written warranty shall be as outlined in attached WARRANTY FOR NON-STRUCTURAL METAL ROOF SYSTEM, and shall start upon final acceptance of the facility. It is required that the Contractor provide a separate bond in an amount equal to the installed total roofing system cost in favor of the owner (Government) covering the Contractor's warranty responsibilities effective throughout the 5 year Contractor's warranty period for the entire roofing system as outlined above.

1.7.2 Manufacturer's Material Warranties

****

NOTE: The 20-year system weathertightness warranty, required in paragraph c. below, will increase construction cost and should be used only after consultation with the customer. Remove paragraph c. below, when not needed in the project.

****

The Contractor shall furnish, in writing, the following manufacturer's material warranties which cover all Non-Structural Metal Roofing System components such as roof panels, flashing, accessories, and trim, fabricated from coil material:

a. A manufacturer's 20 year material warranty warranting that the aluminum, zinc-coated steel, aluminum-zinc alloy coated steel or aluminum-coated steel as specified herein will not rupture, fail structurally, or perforate under normal atmospheric conditions at the site. Liability under this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated, or structurally failed coil material.

b. A manufacturer's 20 year exterior material finish warranty warranting that the factory color finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of 8 when measured in accordance with ASTM D 4214; or fade or change colors in excess of 5 NBS units as measured in accordance with ASTM D 2244. Liability under this warranty is exclusively limited to refinishing or replacing the defective coated coil material.

c. A roofing system manufacturer's 20 year system weathertightness warranty.

1.8 COORDINATION MEETING

A coordination meeting shall be held within 45 days after contract award for mutual understanding of the metal roofing system contract requirements. This meeting shall take place at the building site and shall include representatives from the Contractor, the roofing system manufacturer, the roofing supplier, the erector, the designer, and the Contracting Officer. All items required by paragraph SUBMITTALS shall be discussed, including applicable standard manufacturer shop drawings, and the approval process. The Contractor shall coordinate time and arrangements for the meeting.

PART 2 PRODUCTS

2.1 ROOF PANELS

****
NOTE: See TI 809-29 for guidance on roof slope and other requirements.
****

Panels shall be [steel] [aluminum] and shall have a [mill] [factory color] finish. Length of sheets shall be sufficient to cover the entire length of any unbroken roof slope for slope lengths that do not exceed 30 feet. Sheets longer than 30 feet may be furnished if approved by the Contracting Officer. Width of sheets shall provide nominal [12] [_____] inches of coverage in place. Design provisions shall be made for thermal expansion and contraction consistent with the type of system to be used. All sheets shall be either square-cut or miter-cut. The ridge cap shall be installed as recommended by the metal roofing manufacturer. Height of corrugations, ribs, or seams, at overlap of adjacent roof sheets shall be the building manufacturer's standard for the indicated roof slope.

2.1.1 Steel Panels

****
NOTE: When a factory color finish is specified, remove last two sentences from this paragraph. AZ 50 coating is allowed for factory-color-finished and not for mill finish. Remove this paragraph when steel panels are not used in the project.
****

Zinc-coated steel conforming to ASTM A 653/A 653M; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M, AZ [55] [50] coating; or aluminum-coated steel conforming to ASTM A 463/A 463M, Type 2, coating designation T2 65. Uncoated roof panels shall be 0.024 inch thick minimum. Panels shall be within 95 percent of the nominal thickness. Prior to shipment, mill finish panels shall be treated with a passivating chemical and oiled to inhibit the formation of oxide corrosion products. Panels that have become wet during shipment and have started to oxidize shall be rejected.

2.1.2 Aluminum Panels

****
NOTE: Remove this paragraph when aluminum panels are not used in the project.
****

Alloy conforming to ASTM B 209, temper as required for the forming operation, minimum 0.032 inch thick.

2.2 ACCESSORIES

Accessories shall be compatible with the roofing furnished. Flashing, trim, metal closure strips, caps, and similar metal accessories shall be not less than the minimum thicknesses specified for roof panels. Exposed metal accessories shall be finished to match the panels furnished. Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chloride premolded to match configuration of the panels and shall not absorb or retain water.

2.3 FASTENERS

Fasteners for roof panels shall be zinc-coated steel, aluminum, or nylon capped steel, type and size as recommended by the manufacturer to meet the performance requirements. Fasteners for accessories shall be the manufacturer's standard. Exposed roof fasteners shall be gasketed or have gasketed washers on the exterior side of the roofing to waterproof the fastener penetration. Washer material shall be compatible with the panels; and gasketed portion of fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 1/8 inch thick.

2.4 FACTORY COLOR FINISH

****

NOTE: Factory color finish will be specified except when the buildings are to be used for temporary purposes or where mill finish aluminum panels provide an acceptable appearance. If factory color finish is not required, document the rationale for the decision in the design analysis and remove this paragraph.

The US metal building industry offers a variety of color finishes to protect the metal panels against chemical corrosion and ultraviolet radiation; to provide long life with minimum maintenance plus acceptable weathering and color retention; and to assure chalk, fade, and mar resistance. Some of the most widely used coatings include, but are not limited to, the following:

a. Polyvinylidene fluoride (PVF2); a nominal 0.025 mm (1 mil) thick coating modified with a proprietary resin for toughness; it may be used in most environments.

b. Silicone-modified polyester (SMP); a thermoset coating system composed of polyester resin modified by copolymerization with a functional silicone resin intermediate designed for added protection against chemical corrosion and ultraviolet radiation.

c. Plastisol (PVC); a two-coat system consisting of a polyvinyl-chloride resin dispersed in a plasticizer top-coat over a corrosion-resistant primer; it is a high-performance, thick coating designed for highly aggressive and corrosive environments with excellent resistance to common acids, alkalis, and inorganic compounds.

Most coatings may be ordered extra-thick for buildings in direct contact with salt or chemical laden air or where a premium finish would be justified. The thicker coating provides additional primer and increases the coating's corrosion and

abrasion resistance, but it requires a special run by the coil coater, at least a 22 degrees C (70 degrees F) environment, and additional delivery time. Appropriate specification requirements must be added if thick film coatings are to be used.

The high cost of preventing corrosion of galvanized steel panels, together with the fact that cut edges, scratches and penetrations of the panels expose the steel substrate, warrants consideration for the use of solid aluminum which is inherently less susceptible to damaging corrosion.

Roof panels are available in several standard colors. The standard flashing material is most economical if it is the same thickness and color as the panels. If an accent color is required for the flashings the cost may go up significantly and color selection will be limited. Color other than manufacturer's standard colors will be used only when the extra cost is justified.

Energy considerations must be included in the choice of standard colors for the roof panels. White or light-colored roofing surfaces are much better at reflecting sunlight than darker surfaces. This keeps roofs 20 to 35 degrees C (35 to 60 degrees F) cooler, which means less heat will be transferred to internal building spaces. Demonstration projects have shown that cooling energy use can be cut by as much as 40 percent when light-colored surfaces are used. Coordinate the use of light-colored roofing material with the user.

****

Panels shall have a factory applied [polyvinylidene fluoride] [_____] finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. Color shall match the color indicated [on the drawings] [in Section 09915 COLOR SCHEDULE]. The exterior coating shall be a nominal [1] [2] mil thickness consisting of a topcoat of not less than 0.7 mil dry film thickness and the paint manufacturer's recommended primer of not less than [0.2] [1.0] mil thickness. The exterior color finish shall meet the test requirements specified below.

2.4.1 Cyclic Salt Fog/UV Test

****

NOTE: The results of the salt spray test will vary depending on the thickness of the coating.

****

A sample of the sheets shall withstand a cyclic corrosion test for a minimum of 2016 hours in accordance with ASTM D 5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 10, no blistering, as determined by ASTM D 714; 10, no rusting, as determined by ASTM D 610; and a rating of 6, over 1/16 to 1/8 inch failure at scribe, as determined by ASTM D 1654.

2.4.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 1/8 inch diameter mandrel, the coating film shall show no evidence of fracturing to the naked eye.

2.4.3 Accelerated Weathering, Chalking Resistance and Color Change

****

NOTE: The ASTM G 23 test is considered "outdated and unreliable" by MBMA; it is extremely expensive and labor intensive to run. The ASTM D 4587 test is currently the most reliable accelerated test method for predicting durability.

Low gloss finishes have relatively poor weathering qualities. Delete the last sentence if a low gloss finish is not required by Paragraph Specular Gloss.

****

A sample of the sheets shall be tested in accordance with ASTM D 4587, test condition [B] [D] for [_____] total hours. The coating shall withstand the weathering test without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with tape in accordance with ASTM D 3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. For sheets required to have a low gloss finish, the chalk rating shall be not less than No. 6 and the color difference shall be not greater than 7 units.

2.4.4 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

2.4.5 Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 0.500 inch diameter hemispherical head indenter, equal to 1.5 times the metal thickness in mils, expressed in inch-pounds, with no cracking.

2.4.6 Abrasion Resistance Test

****

NOTE: The 70 percent polyvinylidene fluoride finish has a minimum abrasion resistance of about 65 liters per 0.025 mm (65 liters/mil) of coating thickness.

The nominal 0.025 mm (1 mil) finish will withstand 50 to 60 liters of sand while the nominal 0.050 mm (2 mil) finish can be expected to withstand 80-100 liters. The results of this test are variable and offer poor repeatability. In shop drawing review, notice the difference between the specified total liters of sand and those reported.
****

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of [50] [80] liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

2.4.7 Specular Gloss

****
NOTE: Few manufacturers regularly produce prefinished panels meeting these low gloss requirements and such sheets are available only in limited colors. Standard 70 percent PVF2 finish, for example, has a medium gloss. Low gloss paint formulations result in reduced weathering properties. Identify individual facilities requiring low gloss finish.

For roofs of structures at airfields where glare would be objectionable and may be an operational hazard, the specular gloss value should be limited to 10 or less at an angle of 85 degrees.
****

Finished roof surfaces for [_____] shall have a specular gloss value of [10 or less at an angle of 85 degrees] [30 plus or minus [_____] at 60 degrees] when measured in accordance with ASTM D 523.

2.4.8 Pollution Resistance

Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

2.5 UNDERLAYMENTS

****
NOTE: The designer must determine the appropriate underlayments; all the types specified below could be needed on the project. High risk areas, severe weather conditions, complex roofs, or high value contents must have the higher protection capacity of a rubberized underlayment. Delete the unused types.
****

2.5.1 Felt Underlayment

Felt underlayment shall be No. 30 felt in accordance with ASTM D 226, Type II.

2.5.2 Rubberized Underlayment

Rubberized underlayment shall be equal to "Ice and Water Shield" as manufactured by Grace Construction Products, "Winterguard" as manufactured by CertainTeed Corporation, or "Weather Watch Ice and Water Barrier" as manufactured by GAF Building Materials Corporation.

2.5.3 Slip Sheet

Slip Sheet shall be 5 pounds per 100 sf rosin sized unsaturated building paper.

2.6 INSULATION

****

NOTE: Drawings will show type, R-Value, vapor barrier, extent and location of insulation, including insulation retainer system. Insulation retainer system consists of a grid of bands and cross banks and their connections to hold the insulation neatly in place and against the bottom of the roof panels to ensure condensation does not occur. The insulation retainer system will be detailed on the drawings and specified to allow a practical installation. On warehouse, shop or other storage type facilities, where esthetics is not essential, insulation baskets or poultry netting and their connections may be shown and specified for the insulation retainer system. The insulation location is dependent upon the use or absence of a separate roof deck. The vapor retarder location is dependent on the climate as noted in paragraph VAPOR RETARDER.

The required R-value for the insulation will be determined and shown at the appropriate details on the drawings. The required R-values for the insulation will never be less than the R-values used in the Energy Budget Analysis. The R-values shown on the drawings should be greater than those used in the design analysis to account for thermal bridges. Provide about a one-third increase (or as local experience has shown, if different) in R-value over what is calculated; that is, if an R-value of 3 is needed in metric (metric units are square meter K/W) (16 in I-P with units of h x square feet x degree F/Btu) use an R-value of 4 (21) in the contract. If an analysis of thermal bridges in the design gives a requirement greater or less than this, it should be used.

Flame spread and smoke development ratings of exposed insulation, to include facing, shall comply with the requirements of MIL-HDBK 1008C. Exposed

insulation shall be faced, mineral fiber type, only; cellular plastic insulations shall not be exposed.
****

Thermal resistance of insulation shall be not less than the R-values shown on the contract drawings. R-values shall be determined at a mean temperature of 75 degrees F in accordance with ASTM C 518. Insulation shall be a standard product with the insulation manufacturer, factory marked or identified with insulation manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. [Blanket insulation shall have a facing as specified in paragraph VAPOR RETARDER]. Insulation [, including facings,] shall have a flame spread not in excess of [_____] and a smoke developed rating not in excess of [_____] when tested in accordance with ASTM E 84. The stated R-value of the insulation shall be certified by an independent Registered Professional Engineer if tests are conducted in the insulation manufacturer's laboratory.

2.6.1 Rigid Board Insulation for Use Above a Roof Deck

2.6.1.1 Polyisocyanurate

Polyisocyanurate insulation shall conform to ASTM C 1289, Type I, Class 2 (having a minimum recovered material content of 9 percent by weight of core material in the polyisocyanurate portion). For impermeable faced polyisocyanurate (Ex: aluminum foil) the maximum design R-value per 1 inch of insulation used shall be 7.2.

2.6.1.2 Mineral Fiber

****
NOTE: Remove this paragraph if metal building (batt) or rigid insulation (polyisocyanurate) is used in the project.
****

Insulation shall conform to ASTM C 612.

2.6.1.3 Glass Mat Gypsum Roof Board

****
NOTE: Glass mat gypsum roof board is a fire and water resistant underlayment/overlayment that can be a thermal barrier or protection board for the insulation.
****

Glass mat gypsum roof board for underlayment/overlayment, thermal protection, or insulation protection shall be in accordance with ASTM C 1177/C 1177M.

2.6.2 Blanket Insulation

****
NOTE: The specified blanket insulation is a flexible mineral fiber insulation for use at temperatures up to 176 degrees C (350 degrees F).

****

Blanket insulation shall conform to ASTM C 991.

2.7 INSULATION RETAINERS

Insulation retainers shall be type, size, and design necessary to adequately hold the insulation and to provide a neat appearance. Metallic retaining members shall be nonferrous or have a nonferrous coating. Nonmetallic retaining members, including adhesives used in conjunction with mechanical retainers or at insulation seams, shall have a fire resistance classification not less than that permitted for the insulation.

2.8 SEALANT

Sealant shall be an elastomeric type containing no oil or asphalt. Exposed sealant shall be [colored to match the applicable building color] [clear] and shall cure to a rubberlike consistency. [Sealant placed in the roof panel standing seam ribs shall be provided in accordance with the manufacturer's recommendations.]

2.9 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

2.10 VAPOR RETARDER

****

NOTE: The term vapor retarder has been selected to describe the membrane used to reduce moisture vapor transmission. The location of the vapor retarder is determined by the climate and the building type.

The vapor retarder goes on the side of the insulation with the greatest vapor pressure during the course of the year; therefore, it goes on the outside in a climate predominantly warm, and on the inside in a climate predominantly cool. The designer should determine the most appropriate application/installation of the vapor retarder based on project circumstances and the intended use of facility. See TM 5-810-1 for humid climate definition.

Detail the use of insulation on the drawings. The two systems are as follows:

a. Cool climate. The vapor retarder will be a separate membrane directly on top of the roof deck with board insulation over the vapor retarder and an unfaced blanket cushioning between the board insulation and the roofing.

b. Warm climate. The vapor retarder will be a facing on the top of a blanket insulation above

board insulation. The board insulation sits on the roof deck. A slip sheet is required.

Unreinforced foil as the facing in condition b. above, should not be used.
****

2.10.1 Vapor Retarders as Integral Facing

Insulation facing shall have a permeability of [0.1] [0.02] [_____] perm or less when tested in accordance with ASTM E 96. Facing shall be [white] [gray] [green] [of reinforced foil with a vinyl finish] [sheet vinyl] [; except that unreinforced foil with a natural finish may be used in concealed locations]. Facings and finishes shall be factory applied.

2.10.2 Vapor Retarders Separate from Insulation

****
NOTE: Roof deck should not be assumed to function as a vapor retarder.
****

Vapor retarder material shall be polyethylene sheeting conforming to ASTM D 4397. A single ply of 10 mil polyethylene sheet; or, at the Contractor's option, a double ply of 6 mil polyethylene sheet shall be used. A fully compatible polyethylene tape which has equal or better water vapor control characteristics than the vapor retarder material shall be provided. A cloth industrial duct tape in a utility grade shall also be provided to use as needed to protect the vapor retarder from puncturing.

2.10.3 Slip Sheet for Use With Vapor Retarder

****
NOTE: A slip sheet is required to separate the roofing panels from the insulation facing where the facing would be in direct contact with the roofing panels.
****

Slip sheet for use with vapor retarder shall be a 5 per 100 square foot rosin-sized, unsaturated building paper.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be in accordance with the manufacturer's erection instructions and drawings. Dissimilar materials which are not compatible when contacting each other shall be insulated by means of gaskets or insulating compounds. Improper or mislocated drill holes shall be plugged with an oversize screw fastener and gasketed washer; however, sheets with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces and edges shall be kept clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Stained, discolored, or damaged sheets shall be removed from the site.

3.1.1 Roofing

Side laps shall be laid away from the prevailing winds. Side and end lap distances, joint sealing, and fastening and spacing of fasteners shall be in accordance with manufacturer's standard practice. Spacing of exposed fasteners shall present an orderly appearance. Side laps and end laps of roof panels and joints at accessories shall be sealed. Fasteners shall be driven normal to the surface. Method of applying joint sealant shall conform to the manufacturer's recommendation to achieve a complete weathertight installation. Accessories shall be fastened into substrate, except as otherwise approved. Closure strips shall be provided as indicated and where necessary to provide weathertight construction.

3.1.2 Field Forming of Roof Panels for Unique Areas

When roofing panels are formed from factory-color-finished steel coils at the project site, the same care and quality control measures that are taken in shop forming of roofing panels shall be observed. Rollformer shall be operated by the metal roofing manufacturer's approved installer. In cold weather conditions, preheating of the steel coils to be field formed shall be performed as necessary just prior to the rolling operations.

3.1.3 Underlayment

****

NOTE: The designer must show the extent and location of the appropriate underlayments on the drawings. The underlayments must ensure that any water penetrating below the panels will drain outside of the building envelope; the following are areas of concern: valleys and eaves are subject to damming from ice, leaves and debris causing water to back up under the metal roofing; water running down the roofing may run up under the roofing panels on the opposite side of a valley; panel splices and penetrations.

****

Underlayment types shall be installed where shown on the drawings; they shall be installed directly over the substrate. If a roof panel rests directly on the underlayments, a slip sheet shall be installed as a top layer, beneath the metal roofing panels, to prevent adhesion. All underlayments shall be installed so that successive strips overlap the next lower strip in shingle fashion. Underlayments shall be installed in accordance with the manufacturer's written instructions. The underlayments shall ensure that any water that penetrates below the metal roofing panels will drain outside of the building envelope.

3.2 INSULATION INSTALLATION

****

NOTE: Choose one paragraph and delete the other.

****

Insulation shall be installed as indicated and in accordance with manufacturer's instructions. Insulation shall be continuous over entire roof surface. Where expansion joints, terminations, and other connections are made, the cavity shall be filled with batt insulation and vapor retarder providing equivalent R-Value and perm rating as remaining insulation.

3.2.1 Board Insulation in Warm Climates

Rigid or semirigid board insulation shall be laid in close contact. If more than one layer of insulation is required, joints in the second layer shall be offset from joints in the first layer. A layer of blanket insulation shall be placed over the rigid or semirigid board insulation to be compressed against the underside of the metal roofing to reduce thermal bridging, dampen noise, and prevent roofing flutter. This layer of blanket insulation shall be compressed a minimum of 50 percent. Rigid insulation shall be attached to the metal roof deck with bearing plates and fasteners, as recommended by the insulation manufacturer, so that the insulation joints are held tight against each other, with no less than 1 fastener and bearing plates per 4 square feet of insulation. Layout and joint pattern of insulation and fasteners shall be indicated on the shop drawings.

3.2.2 Board Insulation in Cool Climates

A layer of unfaced blanket insulation shall be placed over the board insulation and held tight against the metal roofing.

3.3 PROTECTION OF VAPOR RETARDER FROM ROOF DECK

****

NOTE: Delete this paragraph if the vapor retarder will not be in direct contact with the roof deck.

****

A cloth industrial duct tape shall be adhered over all the seams of metal roof decking, at any penetration edges, and at all surface areas exhibiting sharp burrs or similar protrusions. For other types of roof decking, cloth industrial duct tape shall be adhered over all irregularities which could potentially puncture polyethylene membrane.

3.4 VAPOR RETARDER INSTALLATION

****

NOTE: Choose one paragraph and delete the other.

****

3.4.1 Integral Facing on Blanket Insulation

Integral facing on blanket insulation shall have the facing lapped and sealed with a compatible tape to provide a vapor tight membrane.

3.4.2 Polyethylene Vapor Retarder

The polyethylene vapor retarder membrane shall be installed over the entire surface. A fully compatible polyethylene tape shall be used to seal the edges of the sheets to provide a vapor tight membrane. Sheet edges shall be lapped not less than 6 inches. Sufficient material shall be provided to avoid inducing stresses in the sheets due to stretching or binding. All tears or punctures that are visible in the finished surface at any time during the construction process shall be sealed with polyethylene tape.

3.5 SLIP SHEET INSTALLATION

****

NOTE: Delete this paragraph if no blanket insulation facing will be compressed against metal roofing.
****

A slip sheet shall be laid over the blanket insulation facing to prevent the vinyl facing from adhering to the metal roofing.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOF SYSTEM

FACILITY DESCRIPTION____

BUILDING NUMBER:____

CORPS OF ENGINEERS CONTRACT NUMBER:________________________________

CONTRACTOR

CONTRACTOR:____

ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

OWNER

OWNER:____

ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

CONSTRUCTION AGENT

CONSTRUCTION AGENT:____

ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOF SYSTEM
(continued)

THE NON-STRUCTURAL METAL ROOF SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY ______________________________ FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE. THE NON-STRUCTURAL METAL ROOFING SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE, BUT SHALL NOT BE LIMITED TO, THE FOLLOWING: THE ENTIRE ROOFING SYSTEM, MANUFACTURER SUPPLIED FRAMING AND STRUCTURAL MEMBERS, METAL ROOF PANELS, FASTENERS, CONNECTORS, ROOF SECUREMENT COMPONENTS, AND ASSEMBLIES TESTED AND APPROVED IN ACCORDANCE WITH UL 580. IN ADDITION, THE SYSTEM PANEL FINISHES, SLIP SHEET, INSULATION, VAPOR RETARDER, ALL ACCESSORIES, COMPONENTS, AND TRIM AND ALL CONNECTIONS ARE INCLUDED. THIS INCLUDES ROOF PENETRATION ITEMS SUCH AS VENTS, CURBS, SKYLIGHTS; INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS; EAVES, RIDGE, HIP, VALLEY, RAKE, GABLE, WALL, OR OTHER ROOF SYSTEM FLASHINGS INSTALLED AND ANY OTHER COMPONENTS SPECIFIED WITHIN THIS CONTRACT TO PROVIDE A WEATHERTIGHT ROOF SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THE SPECIFICATIONS THAT ARE PART OF THE NON-STRUCTURAL METAL ROOFING SYSTEM.

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE ASSOCIATED WITH THE NON-STRUCTURAL METAL ROOF SYSTEM COVERED UNDER THIS WARRANTY SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON ____________________________ AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

____

(Company President) (Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOFING SYSTEM
(continued)

THE CONTRACTOR SHALL SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE NON-STRUCTURAL METAL ROOFING SYSTEM, WHICH SHALL BE SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR WILL BE ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY EXAMPLE.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE NON-STRUCTURAL METAL ROOF DUE TO ACTIONS BY THE OWNER TO INHIBIT FREE DRAINAGE OF WATER FROM THE ROOF AND GUTTERS AND DOWNSPOUTS OR ALLOW PONDING WATER TO COLLECT ON THE ROOF SURFACE. CONTRACTOR'S DESIGN SHALL INSURE FREE DRAINAGE FROM THE ROOF AND NOT ALLOW PONDING WATER.

6. THIS WARRANTY APPLIES TO THE NON-STRUCTURAL METAL ROOFING SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR; AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES.

**

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOF SYSTEM
(continued)

**REPORTS OF LEAKS AND ROOF SYSTEM DEFICIENCIES SHALL BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE, BY TELEPHONE OR IN WRITING, FROM EITHER THE OWNER OR CONTRACTING OFFICER. EMERGENCY REPAIRS TO PREVENT FURTHER ROOF LEAKS SHALL BE INITIATED IMMEDIATELY; A WRITTEN PLAN SHALL BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS ROOF SYSTEM WITHIN SEVEN (7) CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT SHALL BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE NON-STRUCTURAL METAL ROOF SYSTEM REPAIRED OR REPLACED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR.

IN THE EVENT THE CONTRACTOR DISPUTES THE EXISTENCE OF A WARRANTABLE DEFECT, THE CONTRACTOR MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. THE REQUEST FOR AN ARBITRATOR MUST BE MADE WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED, THE PARTIES SHALL, WITHIN TEN (10) DAYS, JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES SHALL CONFER WITHIN TEN (10) DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE (1) NAME REMAINS. THE REMAINING PERSON SHALL BE THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED, ETC., SHALL BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT SHALL PAY FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. A WRITTEN ARBITRATOR'S DECISION WILL BE REQUESTED NOT LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT.

A FRAMED COPY OF THIS WARRANTY SHALL BE POSTED IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

****

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS

CEGS-07413 (July 1997)

Superseding
CEGS-07413 (October 1991)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 1 (September 1999)

Latest change indicated by CHG tags

****

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07/97

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****
DEPARTMENT OF THE ARMY **CEGS-07413 (July 1997)**
U.S. ARMY CORPS OF ENGINEERS **----------------------**
Superseding
CEGS-07413 (October 1991)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 1 (September 1999)

Latest change indicated by CHG tags

****

SECTION 07413

METAL SIDING
07/97

****
NOTE: This guide specification covers the requirements for both factory color and mill finish metal siding. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: This guide specification will be used in the preparation of project specifications for metal siding applied to supporting structure or framing designed by the Government. If a standard metal building including siding, is required, Section 13120 STANDARD METAL BUILDING SYSTEMS will be used. If a special purpose metal building including siding, is required, Section 13121 SPECIAL PURPOSE METAL BUILDING SYSTEMS will be used.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA Design Manual	(1994) Aluminum Design Manual: Specifications and Guidelines for Aluminum Structures

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI Cold-Formed Mnl	(1996) Cold-Formed Steel Design Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 463/A 463M	(1997) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 653/A 653M	(1998) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 792/A 792M	(1997) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	(1995) Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C 518	(1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM D 522	(1993a) Mandrel Bend Test of Attached Organic Coatings
ASTM D 610	(1995) Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D 714	(1987; R 1994) Evaluating Degree of Blistering of Paints
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 1654	(1992) Evaluation of Painted or Coated

	Specimens Subjected to Corrosive Environments
ASTM D 2244	(1995) Calculation of Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	(1997) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	(1993) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM D 4214	(1998) Evaluating Degree of Chalking of Exterior Paint Films
ASTM D 4397	(1996) Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 4587	(1991) Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light- and Water- Exposure Apparatus
ASTM D 5894	(1996) Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV Condensation Cabinet)
ASTM E 84	(1998e1)` Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1995) Minimum Design Loads for Buildings and Other Structures

1.2 GENERAL REQUIREMENTS

1.2.1 Design

****

NOTE: Drawings will show the design wind loads and supports to receive the metal siding.

****

Criteria, loading combinations, and definitions shall be in accordance with ASCE 7. Maximum calculated fiber stress shall not exceed the allowable value in the AISI or AA manuals; a one third overstress for wind is allowed. Midspan deflection under maximum design loads shall be limited to L/180. Contract drawings show the design wind loads and the extent and general assembly details of the metal siding. Members and connections not shown on the drawings shall be designed by the Contractor. Siding panels and accessories shall be the products of the same manufacturer. Steel siding design shall be in accordance with AISI Cold-Formed Mnl. Aluminum siding design shall be in accordance with AA Design Manual.

1.2.2 Architectural Considerations

****
NOTE: Project Architect will provide panel profile dimensions on the drawings when a particular aesthetic appearance is desired. Otherwise delete this paragraph.
****

Panels profile shall be as shown on the drawings.

1.3 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Siding; [_____].

Drawings consisting of catalog cuts, design and erection drawings, shop coating and finishing specifications, and other data as necessary to clearly describe design, materials, sizes, layouts, construction details, fasteners, and erection. Drawings shall be accompanied by engineering design calculations for the siding panels.

SD-13 Certificates

Siding; [_____]. Installation; [_____]. Accessories; [_____].

Certificates attesting that the panels and accessories conform to the requirements specified. Certified laboratory test reports showing that the sheets to be furnished are produced under a continuing quality control program and that a representative sample consisting of not less than 5 pieces has been tested and has met the quality standards specified for factory color finish. Mill certification for structural bolts, siding, and wall liner panels.

Insulation; [_____].

Certificate attesting that the insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

SD-14 Samples

Accessories; [_____].

One sample of each type of flashing, trim, closure, cap and similar items. Size shall be sufficient to show construction and configuration.

Siding; [_____].

One piece of each type and finish (exterior and interior) to be used, 9 inches long, full width.

Fasteners; [_____].

Two samples of each type to be used with statement regarding intended use. If so requested, random samples of bolts, nuts, and washers as delivered to the jobsite shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

Insulation; [_____].

One piece of each type to be used, and descriptive data covering installation.

Gaskets and Insulating Compounds; [_____].
Two samples of each type to be used and descriptive data.

Sealant; [_____].

One sample, approximately 1 pound, and descriptive data.

Wall Liners; [_____].

One piece, 9 inches long, full width.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials shall be covered with weathertight coverings and kept dry. Storage accommodations for metal siding shall provide good air circulation and protection from surface staining.

1.5 WARRANTIES

The Contractor shall provide a weather tight warranty for the metal siding for a period of 20 years to include siding panel assembly, 10 years against the wear of color finish, and 10 years against the corrosion of fasteners caused by ordinary wear and tear by the elements. The warranties shall start upon final acceptance of the work or the date the Government takes possession, whichever is earlier.

PART 2 PRODUCTS

2.1 SIDING

****

NOTE: This paragraph will be edited to reflect the project requirements with regard to panel finish, edge configuration, and fastening system. Except for special situations, steel and aluminum will be retained as options for siding materials. Where appearance is not important, the designer will leave the overlapping or interlocking configurations and the exposed penetrating fasteners or the nonpenetrating fastener system as alternative choices for siding.

****

Panels shall be [steel] [aluminum] and shall have a [mill] [factory color] finish. Length of sheets shall be sufficient to cover the entire height of any unbroken wall surface when length of run is 30 feet or less. When length of run exceeds 30 feet, each sheet in the run shall extend over two or more spans. Sheets longer than 30 feet may be furnished if approved by the Contracting Officer. Width of sheets [with overlapping configurations shall provide not less than 24 inches of coverage in place] [, and those] [with interlocking ribs shall provide not less than 12 inches of coverage in place].

2.1.1 Wall Panels

Wall panels shall have [edge configurations for overlapping adjacent sheets] [or] [interlocking ribs for securing adjacent sheets]. Wall panels shall be fastened to framework using [exposed] [or] [concealed] fasteners.

2.1.2 Steel Panels

****

NOTE: When a factory color finish is specified, remove last two sentences from this paragraph. AZ 50 coating is allowed for factory-color-finished and not for mill finish. Remove this paragraph when steel panels are not used in the project.

****

Zinc-coated steel conforming to ASTM A 653/A 653M; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M, AZ [55] [50] coating; or aluminum-coated steel conforming to ASTM A 463/A 463M, Type 2, coating designation T2 65. Uncoated wall panels shall be 0.024 inchthick minimum. Prior to shipment, mill finish panels shall be treated with a passivating chemical and oiled to inhibit the formation of oxide corrosion products. Panels that have become wet during shipment but have not started to oxidize shall be dried, retreated, and re-oiled.

2.1.3 Aluminum Panels

****

NOTE: Remove this paragraph when aluminum panels are not used in the project.

****

Alloy conforming to ASTM B 209, temper as required for the forming operation, minimum 0.032 inch thick.

2.1.4 Factory Insulated Panels

****

NOTE: Where factory insulated panels are necessary for walls in order to meet portability requirements or other operational requirements, this paragraph will be used in conjunction with the previous paragraphs properly edited as required for the design.

Select flame spread rating of 25 and smoke developed rating of 50 for Class A interior finish as defined in NFPA 101, and select 75/100 for Class B interior finish. The designer will determine the required R-value of the assembled panel at 24 degrees C (75 degrees F) in accordance with ASTM C 236, and will show the R-value at the appropriate detail on the drawings.

****

Insulated wall panels shall be factory-fabricated units with insulating core between metal face sheets, securely fastened together and uniformly separated with rigid spacers; facing of [steel] [aluminum] of composition and gauge specified for siding; and constructed to eliminate condensation on interior of the panel. Panels shall have a [factory color] [mill] finish. Insulation shall be compatible with adjoining materials; nonrunning and nonsettling; capable of retaining its R-value for the life of the metal facing sheets; and unaffected by extremes of temperature and humidity. The assembly shall have a flame spread rating not higher than [25] [75], and smoke developed rating not higher than [50] [100] when tested in accordance with ASTM E 84. The insulation shall remain odorless, free from mold, and not become a source of food and shelter for insects. Panels shall be not less than 8 inches wide and shall be in one piece for unbroken wall heights.

2.2 FACTORY COLOR FINISH

****

NOTE: Factory color finish will be specified except when the buildings are to be used for temporary purposes or where mill finish aluminum panels provide an acceptable appearance. If factory color finish is not required, document the rationale for the decision in the design analysis and remove this paragraph.

The US metal building industry offers a variety of color finishes to protect the metal panels against chemical corrosion and ultraviolet radiation; to provide long life with minimum maintenance plus acceptable weathering and color retention; and to assure chalk, fade, and mar resistance. Some of the

most widely used coatings include, but are not limited to, the following:

a. Polyvinylidene fluoride (PVF2); a nominal 0.025 mm (1 mil) thick coating modified with a proprietary resin for toughness; it may be used in most environments.

b. Silicone-modified polyester (SMP); a thermoset coating system composed of polyester resin modified by copolymerization with a functional silicone resin intermediate designed for added protection against chemical corrosion and ultraviolet radiation.

c. Plastisol (PVC); a two-coat system consisting of a polyvinyl-chloride resin dispersed in a plasticizer top-coat over a corrosion-resistant primer; it is a high-performance, thick coating designed for highly aggressive and corrosive environments with excellent resistance to common acids, alkalis, and inorganic compounds.

Most coatings may be ordered extra-thick for buildings in direct contact with salt or chemical laden air or where a premium finish would be justified. The thicker coating provides additional primer and increases the coating's corrosion and abrasion resistance but it requires a special run by the coil coater, at least a 22 degrees C (70 degrees F) environment, and additional delivery time. Appropriate specification requirements must be added if thick film coatings are to be used.

The high cost of preventing corrosion of galvanized steel panels, together with the fact that cut edges, scratches and penetrations of the panels expose the steel substrate, warrants consideration for the use of solid aluminum which is inherently less susceptible to damaging corrosion.

Exterior wall panels are available in several standard colors. Standard trim colors are usually more limited. Except where interior surfaces receive a factory color coat, the exposed reverse side of the panels normally are provided with an off-white backer coating. Color other than manufacturer's standard colors will be used only when the extra cost is justified.

The choice of coating for the interior face of panels depends on environmental and aesthetic considerations. Where a corrosive atmosphere is anticipated within the structure, the finish should be PVF2 in a thickness appropriate to the

environment. For utilitarian facilities with little likelihood of a detrimental atmosphere, a standard backer coat is appropriate. Backer coat is the manufacturer's standard coating (usually polyester based) applied to the back side of the metal panel. This coating is normally a wash coating and is not controlled for consistent color or gloss. Where interior surfaces are concealed behind insulation, liner panels, etc., provide only a primer coat. These finishes should not be confused with a wash coat which is used primarily to facilitate the coil forming process and which is not closely controlled for color, gloss or film thickness. The designer's rational for using any special interior finish should be reflected in the design analysis.

Energy considerations must be included in the choice of standard colors for the wall panels. White or light-colored siding surfaces are much better at reflecting sunlight than darker surfaces, transferring less heat to internal building spaces. Coordinate the use of light-colored siding material with the user.

****

Panels shall have a factory applied [polyvinylidene fluoride] [_____] finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. Color shall match the color indicated [on the drawings] [in Section 09915 COLOR SCHEDULE]. The exterior coating shall be a nominal [1] [2] mil thickness consisting of a topcoat of not less than 0.7 mil dry film thickness and the paint manufacturer's recommended primer of not less than [0.2] [1.0] mil thickness. The interior color finish shall consist of [the same coating and dry film thickness as the exterior] [a nominal 1 mil thick [PVF2] [_____] finish otherwise the same as the exterior] [a backer coat with a dry film thickness of 0.5 mil] [a 0.2 milthick prime coat]. The exterior color finish shall meet the test requirements specified below.

2.2.1 Salt Spray Test

****

NOTE: The results of the salt spray test will vary depending on the thickness of the coating.

****

A sample of the sheets shall withstand a cyclic corrosion test for a minimum of 2016 hours in accordance with ASTM D 5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 10, no blistering, as determined by ASTM D 714; 10, no rusting, as determined by ASTM D 610; and a rating of 6, 1/16 to 1/8 inch failure at scribe, as determined by ASTM D 1654.

2.2.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 1/8 inch diameter mandrel, the coating film shall show no evidence of fracturing to the naked eye.

2.2.3 Accelerated Weathering, Chalking Resistance and Color Change

****

NOTE: The ASTM G 23 test is considered "outdated and unreliable" by MBMA; it is extremely expensive and labor intensive to run. The ASTM D 4587 test is currently the most reliable accelerated test method for predicting durability. Also worth considering is the ASTM D 4141 test.

Low gloss finishes have relatively poor weathering qualities. Delete the last sentence if a low gloss finish is not required.

****

A sample of the sheets shall be tested in accordance with ASTM D 4587, test condition [B] [D] for [_____] total hours. The coating shall withstand the weathering test without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with tape in accordance with ASTM D 3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. For sheets required to have a low gloss finish, the chalk rating shall be not less than No. 6 and the color difference shall be not greater than 7 units.

2.2.4 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

2.2.5 Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 0.500 inch diameter hemispherical head indenter, equal to 1.5 times the metal thickness in mils, expressed in inch-pounds, with no loss of adhesion.

2.2.6 Abrasion Resistance Test

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of [50] [80] liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

2.3 ACCESSORIES

Flashing, trim, metal closure strips, caps, and similar metal accessories shall be the manufacturer's standard products. Exposed metal accessories shall be finished to match the panels furnished. Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chlorided premolded to match configuration of the panels and shall not absorb or retain water.

2.4 FASTENERS

****

NOTE: Fasteners that are not color coated may be limited to 300-series corrosion resisting steel when justified by atmospheric exposure conditions.

****

Fasteners for steel panels shall be zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for aluminum panels shall be aluminum or corrosion resisting steel. Fasteners for attaching wall panels to supports shall provide both tensile and shear strength of not less than 750 pounds per fastener. Fasteners for accessories shall be the manufacturer's standard. Exposed wall fasteners shall be color finished or provided with plastic color caps to match the panels. Nonpenetrating fastener system for wall panels using concealed clips shall be manufacturer's standard for the system provided.

2.4.1 Screws

Screws shall be as recommended by the manufacturer.

2.4.2 End-Welded Studs

Automatic end-welded studs shall be shouldered type with a shank diameter of not less than 3/16 inch and cap or nut for holding panels against the shoulder.

2.4.3 Explosive Actuated Fasteners

Fasteners for use with explosive actuated tools shall have a shank of not less than 0.145 inch with a shank length of not less than 1/2 inch for fastening panels to steel and not less than 1 inch for fastening panels to concrete.

2.4.4 Blind Rivets

Blind rivets shall be aluminum with 3/16 inch nominal diameter shank or stainless steel with 1/8 inch nominal diameter shank. Rivets shall be threaded stem type if used for other than the fastening of trim. Rivets with hollow stems shall have closed ends.

2.4.5 Bolts

Bolts shall be not less than 1/4 inch diameter, shouldered or plain shank as required, with proper nuts.

2.5 INSULATION

****

NOTE: Drawings will show type, extent, and location of insulation. The vapor retarder location is dependent on the climate as noted in paragraph VAPOR RETARDER.

The required R-value for the insulation will be determined and shown at the appropriate details on the drawings. The required R-values for the insulation will never be less than the R-values used in the Energy Budget Analysis. The R-values shown on the drawings should be greater than those use in the design analysis to account for thermal bridges. Provide about a one-third increase (or as local experience has shown, if different) in R-value over what is calculated; that is, if an R-value of 3 is needed in metric (metric units are square meter K/W) (16 in I-P with units of h x square feet x degree F/Btu) use an R-value of 4 (21) in the contract. If an analysis of thermal bridges in the design gives a requirement greater or less than this, it should be used.

Flame spread rating of 75 or less and smoke development rating of 150 or less should be used when insulation is enclosed with noncombustible materials. Flame spread and smoke development ratings of exposed insulation, to include facing, shall comply with the requirements of MIL HDBK 1008B. Exposed insulation shall be faced, mineral fiber type, only; cellular plastic insulations shall not be exposed.
****

Thermal resistance of insulation shall be not less than the R-values shown on the contract drawings. R-values shall be determined at a mean temperature of 75 degrees F in accordance with ASTM C 518. Insulation shall be a standard product with the insulation manufacturer, factory-marked or identified with insulation manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. [Blanket insulation shall have a facing as specified in paragraph VAPOR RETARDER]. Insulation [, including facings,] shall have a flame spread not in excess of [_____] and a smoke developed rating not in excess of [_____] when tested in accordance with ASTM E 84. The stated R-value of the insulation shall be certified by an independent Registered Professional Engineer if tests are conducted in the insulation manufacturer's laboratory.

2.6 VAPOR RETARDER

****
NOTE: The term vapor retarder has been selected to describe the membrane used to reduce moisture vapor transmission. The location of the vapor retarder is determined by the climate and the building type; the vapor retarder goes on the side of the insulation with the greatest vapor pressure during the course of the year; therefore, it goes on the outside in a warm climate, and on the inside in a cool climate. The designer should determine the most appropriate application/installation of the vapor retarder based

on project conditions and the proposed facility use. See TM 5-810-1 for humid climate definition.
****

2.6.1 Vapor Retarders as Integral Facing

Insulation facing shall have a permeability of [0.1] [0.02] [_____] perm or less when tested in accordance with ASTM E 96. Facing shall be [white] [gray] [green] [of reinforced foil with a vinyl finish] [sheet vinyl] [; except that unreinforced foil with a natural finish may be used in concealed locations]. Facings and finishes shall be factory applied.

2.6.2 Vapor Retarders Separate from Insulation

Vapor retarder material shall be polyethylene sheeting conforming to ASTM D 4397. A single ply of 10 mil polyethylene sheet or, at the Contractor's option, a double ply of 6 mil polyethylene sheet shall be used. A fully compatible polyethylene tape which has equal or better water vapor control characteristics than the vapor retarder material shall be provided. A cloth industrial duct tape in a utility grade shall also be provided to use as needed to protect the vapor retarder from puncturing.

2.7 WALL LINERS

****
NOTE: Wall liners will be specified when necessary to provide protection to the insulation and will be the minimum height consistent with the use of the building. When full-height liners are required, they should be specified under this paragraph in lieu of using factory insulated panels. Wall liners of plywood, hardboard or other suitable materials may be used when considered to be more appropriate than sheet metal liners and when these materials will meet the fire hazard classifications required for the installation. If alternative liners are used, omit the this paragraph and show the supplementary supports for the liner on the drawings.
****

Wall liners shall be 0.024 inch thick minimum for aluminum or 0.018 inch thick minimum for steel with the same composition specified for siding, and formed or patterned to prevent waviness and distortion, and shall extend from floor to [a height of not less than [_____] feet above the floor.] [the ceiling.] Matching metal trim shall be provided at [base of wall liner,] [top of wall liner,] [around openings in walls] [and over interior and exterior corners]. Wall liners shall have [the same factory color finish as specified for the wall panels.] Colors shall be [selected from manufacturer's standard finishes] [as indicated].

2.8 SEALANT

Sealant shall be an elastomeric type containing no oil or asphalt. Exposed sealant shall be [colored to match the applicable building color] [clear] and shall cure to a rubberlike consistency.

2.9 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

PART 3   EXECUTION

3.1   INSTALLATION

Installation shall be in accordance with the manufacturer's erection instructions and drawings. Dissimilar materials which are not compatible when contacting each other shall be insulated from each other by means of gaskets or insulating compounds. Improper or mislocated drill holes shall be plugged with an oversize screw fastener and gasketed washer; however, panels with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces and edges shall be kept clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Stained, discolored, or damaged sheets shall be removed from the site.

3.1.1   Siding and Accessories

****

NOTE: When factory insulated panels are used, the terminology in this paragraph will be modified as necessary to cover their installation.

****

Siding shall be applied with the longitudinal configurations in the vertical position. Accessories shall be fastened into framing members, except as otherwise approved. Closure strips shall be provided as indicated and where necessary to provide weathertight construction.

3.1.1.1   Lap Type Panels with Exposed Fasteners

End laps shall be made over framing members with fasteners into framing members approximately 2 inches from the end of the overlapping sheet. Side laps shall be laid away from the prevailing winds. Spacing of fasteners shall present an orderly appearance and shall not exceed: 8 inches on center at end laps of siding, 8 inches on center at connection of siding to intermediate supports, and 18 inches on center at side laps of siding except when otherwise approved. Side and end laps of siding and joints at accessories shall be sealed. Fasteners shall be installed in straight lines within a tolerance of 1/2 inch in the length of a bay. Fasteners shall be driven normal to the surface and to a uniform depth to seat the gasketed washers properly.

3.1.1.2   Concealed Fastener Wall Panels

Panels shall be fastened to framing members with concealed fastening clips or other concealed devices standard with the manufacturer. Spacing of fastening clips and fasteners shall be in accordance with the manufacturer's written instructions. Spacing of fasteners and anchor clips along the panel interlocking ribs shall not exceed 12 incheson center except when otherwise approved. Fasteners shall not puncture metal sheets except as approved for flashing, closures, and trim; exposed fasteners shall be installed in straight lines. Interlocking ribs shall be sealed with factory-applied sealant. Joints at accessories shall be sealed.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-07416 (October 1998)**
U.S. ARMY CORPS OF ENGINEERS **-------------------------**
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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 07416

STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM
10/98

****
NOTE: This guide specification covers the requirements for both factory color and mill finish SSSMR systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: This guide specification will be used in the preparation of project specifications for SSSMR systems. SSSMR is a system of metal roof panels supported and/or attached by clips fastened directly to the building structure. For non-structural standing seam metal roof systems use Section 07412 NON-STRUCTURAL METAL ROOFING.

This guide specification will be used in conjunction with Section 13120 STANDARD METAL BUILDING SYSTEMS or Section 13121 METAL BUILDING SYSTEMS (MINOR REQUIREMENTS), when a SSSMR is required for that

type of construction.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA Design Manual (1994) Aluminum Design Manual: Specification & Guidelines for Aluminum Structures

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC ASD Spec (1989) Specification for Structural Steel Buildings - Allowable Stress Design, Plastic Design

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI Cold-Formed Mnl (1996) Cold-Formed Steel Design Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 463/A 463M (1997) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process

ASTM A 653/A 653M (1998) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A 792/A 792M (1997) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

ASTM B 209 (1996) Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B 209M (1995) Aluminum and Aluminum-Alloy Sheet and Plate (Metric)

ASTM C 518 (1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

ASTM C 991 (1998) Flexible Glass Fiber Insulation for Pre-Engineered Metal Buildings

ASTM C 1177/C 1177M (1996) Glass Mat Gypsum Substrate for Use

	as Sheathing
ASTM C 1289	(1998) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D 522	(1993a) Mandrel Bend Test of Attached Organic Coatings
ASTM D 523	(1989; R 1994) Specular Gloss
ASTM D 610	(1995) Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D 714	(1987; R 1994) Evaluating Degree of Blistering of Paints
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 1308	(1987; R 1998) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2244	(1995) Calculation of Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	(1997) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	(1993) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM D 4214	(1998) Evaluating Degree of Chalking of Exterior Paint Films
ASTM D 4397	(1996) Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 4587	(1991) Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light- and Water-Exposure Apparatus
ASTM D 5894	(1996) Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
ASTM E 84	(1998e1) Surface Burning Characteristics of Building Materials

ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM E 1592	(1995) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1995) Minimum Design Loads for Buildings and Other Structures

STEEL JOIST INSTITUTE (SJI)

SJI Specs & Tables	(1994) Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders

1.2 GENERAL REQUIREMENTS

****

NOTE: Metal roof panels are capable of spanning the structural supports and resisting snow, dead, live, concentrated, and wind loads without benefit of additional substrate materials. Substrates provided in conjunction with SSSMR systems are not a requirement of this specification and are referred to as roof decks.

For Government designed buildings, the roof framing system must show necessary structural framing members, purlins, or subpurlins to accommodate concealed anchor clip spacing. Concealed anchor clip spacing cannot exceed 760 mm (30 inches) on center in the high wind areas, generally at eaves, rakes, and ridges, and 1.4 m (5'-0") on center for the remainder of the roof. All concealed anchor clips must be attached to the framing system. Clip attachments to metal decks or other substrates are not permitted.

Valleys must be properly designed to ensure that water does not travel up under the offset cleat where the panel terminates. Valley backup plates shall be large enough to carry the valley flashing and the panel terminations. Subpurlins must have minimum thicknesses and strengths as required by the specifications.

The contract drawings will include loading diagrams/tables showing the design wind uplift pressures for all zones as determined by ASCE 7 or TI 809-01. The contract drawings will also include snow loading diagrams/tables where appropriate. The roof slope will be indicated on the drawings. Roof slopes will be specified in accordance with TI

809-29. SSSMR system must be designed to accommodate effects of ice damming and other conditions in cold climates.

A wide variety of roof system configurations, fastening systems, and accessories is available. Details of valley, expansion joints, flashing, underlayments, roof penetrations, curbs, eaves, ridges, intersection and other unique situations of the roof system will be shown on the contract drawings.

****

The Contractor shall furnish a commercially available roofing system which satisfies all requirements contained herein and has been verified by load testing and independent design analyses to meet the specified design requirements.

1.2.1 Structural Standing Seam Metal Roof (SSSMR) System

The SSSMR system covered under this specification shall include the entire roofing system; the standing seam metal roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with ASTM E 1592. In addition, the system shall consist of panel finishes, slip sheet, insulation, vapor retarder, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, curbs, skylights; interior or exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system.

1.2.2 Manufacturer

The SSSMR system shall be the product of a manufacturer who has been in the practice of manufacturing and designing SSSMR systems for a period of not less than 3 years and has been involved in at least five projects similar in size and complexity to this project.

1.2.3 Installer

The installer shall be certified by the SSSMR system manufacturer to have experience in installing at least three projects that are of comparable size, scope and complexity as this project for the particular roof system furnished. The installer may be either employed by the manufacturer or be an independent installer.

1.3 DESIGN REQUIREMENTS

****

NOTE: When the SSSMR system is a component of a metal building system, the loading criteria specified in Section 13120 STANDARD METAL BUILDING SYSTEMS or Section 13121 METAL BUILDING SYSTEMS (MINOR REQUIREMENTS), will apply and these paragraphs will be coordinated accordingly. A reference to the pertinent Section will be made for design conditions, and applicable paragraphs of

Section 13120 or Section 13121 will be edited accordingly.

****

The design of the SSSMR system shall be provided by the Contractor as a complete system. Members and connections not indicated on the drawings shall be designed by the Contractor. Roof panels, components, transitions, accessories, and assemblies shall be supplied by the same roofing system manufacturer.

1.3.1 Design Criteria

****

NOTE: Loads and load combinations will be in accordance with ASCE 7. The designer will provide loading diagrams/tables on the contract drawings, plus dimensions of edge, eave, ridge and corner zones.

****

Design criteria shall be in accordance with ASCE 7.

1.3.2 Dead Loads

The dead load shall be the weight of the SSSMR system. Collateral loads such as sprinklers, mechanical and electrical systems, and ceilings shall not be attached to the panels.

1.3.3 Live Loads

1.3.3.1 Concentrated Loads

The panels and anchor clips shall be capable of supporting a 300 pound concentrated load. The concentrated load shall be applied at the panel midspan and will be resisted by a single standing seam metal roof panel assumed to be acting as a beam. The undeformed shape of the panel shall be used to determine the section properties.

1.3.3.2 Uniform Loads

****

NOTE: The minimum roof live load will be not less than 960 Pa (20 psf).

****

The panels and concealed anchor clips shall be capable of supporting a minimum uniform live load of [20] [_____] psf.

1.3.4 Roof Snow Loads

****

NOTE: Snow load, including unbalanced roof snow loads and drift load will be calculated in accordance with ASCE 7.

****

The design roof snow loads shall be as shown on the contract drawings.

1.3.5   Wind Loads

****

NOTE: The internal pressure coefficient for buildings shall be in accordance with ASCE 7. The internal pressures also apply to SSSMR systems above substrates since the panels do not lay directly on the substrate.

****

The design wind uplift pressure for the roof system shall be as shown on the contract drawings. The design uplift force for each connection assembly shall be that pressure given for the area under consideration, multiplied by the tributary load area of the connection assembly. The safety factor listed below shall be applied to the design force and compared against the ultimate capacity. Prying shall be considered when figuring fastener design loads.

a. Single fastener in each connection.........3.0

b. Two or more fasteners in each connection...2.25

1.3.6   Thermal Loads

****

NOTE: Select appropriate temperature range based on effects of direct sun and general climatic conditions of the project site.

Insulated structures experience greater temperature differences than that of uninsulated structures. For specific projects, giving consideration to the panel color, building location, infrared heating by the sun, and the cooling effect of the roof radiating into the night sky, the designer should use a maximum temperature range of 104 degrees C (220 degrees F) for an insulated building and a maximum temperature range of 71 degrees C (160 degrees F) for an uninsulated building to compensate for the differential movement between the roof panels and the structural framework.

For wood structures, insulated buildings that are temperature sensitive, or in extreme climate areas, a greater temperature range should be considered. Dark roofs in mountain areas may be subject to a temperature range of 116 degrees C (240 degrees F) or more. For lateral expansion the thermal movement may be assumed to be absorbed in the standing seam rib.

****

Roof panels shall be free to move in response to the expansion and contraction forces resulting from a total temperature range of [_____] degrees F during the life of the structure.

1.3.7   Framing Members Supporting the SSSMR System

Any additions/revisions to framing members supporting the SSSMR system to accommodate the manufacturer/fabricator's design shall be the Contractor's responsibility and shall be submitted for review and approval. New or revised framing members and their connections shall be designed in accordance with [AISC ASD Spec] [AISI Cold-Formed Mnl] [SJI Specs & Tables]. Maximum deflection under applied live load, snow, or wind load shall not exceed 1/180 of the span length.

1.3.8   Roof Panels Design

Steel panels shall be designed in accordance with AISI Cold-Formed Mnl. Aluminum panels shall be designed in accordance with AA Design Manual. The structural section properties used in the design of the panels shall be determined using the unloaded shape of the roof panels. The calculated panel deflection from concentrated loads shall not exceed 1/180 of the span length. The calculated panel deflection under applied live load, snow, or wind load shall not exceed 1/180 times the span length. Deflections shall be based on panels being continuous across three or more supports. Deflection shall be calculated and measured along the major ribs of the panels.

1.3.9   Accessories and Their Fasteners

Accessories and their fasteners shall be capable of resisting the specified design wind uplift forces and shall allow for thermal movement of the roof panel system. Exposed fasteners shall not restrict free movement of the roof panel system resulting from thermal forces. There shall be a minimum of two fasteners per clip. Single fasteners with a minimum diameter of 3/8 inch will be allowed when the supporting structural members are prepunched or predrilled.

1.4   PERFORMANCE REQUIREMENTS

****

NOTE: Testing is required to verify the adequacy of the SSSMR system. External reinforcement of panel seams is not permitted, except when approved by the customer and the designer. Consider the use of closer purlin spacing and/or narrow width panels (305 mm (12 inches)) in order to eliminate the need for external reinforcement. External reinforcement includes clips, and clamps on the ribs or seams.

****

The SSSMR shall be tested for wind uplift resistance in accordance with ASTM E 1592; SSSMR systems previously tested and approved by the Corps of Engineers' STANDARD TEST METHOD FOR STRUCTURAL PERFORMANCE OF SSMRS BY UNIFORM STATIC AIR PRESSURE DIFFERENCE may be acceptable. Two tests shall be performed. Test 1 shall simulate the edge condition with one end having crosswise restraint and other end free of crosswise restraint. The maximum span length for the edge condition shall be 30 inches. Test 2 shall simulate the interior condition with both ends free of crosswise restraint. The maximum span length for the interior condition shall be 5.0 feet. External reinforcement, such as clamps on the ribs, [may] [shall not] be installed to improve uplift resistance. Bolts through seams shall not be installed.

1.5 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Design Analysis; GA.

Design analysis signed by a Registered Professional Engineer employed by the SSSMR manufacturer. The design analysis shall include a list of the design loads, and complete calculations for the support system (when provided by the Contractor), roofing system and its components; valley designs, gutter/downspout calculations, screw pullout test results, and shall indicate how expected thermal movements are accommodated.

SD-04 Drawings

Structural Standing Seam Metal Roof System; GA.

Metal roofing drawings and specifications and erection drawings; shop coating and finishing specifications; and other data as necessary to clearly describe design, materials, sizes, layouts, standing seam configuration, construction details, provisions for thermal movement, line of panel fixity, fastener sizes and spacings, sealants and erection procedures. Drawings shall reflect the intent of the architectural detailing using the manufacturer's proprietary products and fabricated items as required. The SSSMR system shop drawings shall be provided by the metal roofing manufacturer.

SD-08 Statements

Qualifications; [_____].

Qualifications of the manufacturer and installer.

SD-09 Reports

Test Report for Uplift Resistance of the SSSMR; GA.

The report shall include the following information:

a. Details of the SSSMR system showing the roof panel cross-section with dimensions and thickness.

b. Details of the anchor clip, dimensions, and thickness.

c. Type of fasteners, size, and the number required for each connection.

d. Purlins/subpurlins size and spacing used in the test.

e. Description of the seaming operation including equipment used.

f. Maximum allowable uplift pressures. These pressures are determined from the ultimate load divided by a factor of safety equal to 1.65.

g. Any additional information required to identify the SSSMR system tested.

h. Signature and seal of an independent registered engineer who witnessed the test.

SD-13 Certificates

Structural Standing Seam Metal Roof System; [_____].

a. Certification that the actual thickness of uncoated sheets used in SSSMRS components including roofing panels, subpurlins, and concealed anchor clips complies with specified requirements.

b. Certification that materials used in the installation are mill certified.

c. Previous certification of SSSMR system tested under the Corps of Engineers' Standard Test Method in lieu of ASTM E 1592 testing.

d. Certification that the sheets to be furnished are produced under a continuing quality control program and that a representative sample consisting of not less than three pieces has been tested and has met the quality standards specified for factory color finish.

e. Certification of installer. Installer certification shall be furnished.

f. Warranty certificate. At the completion of the project the Contractor shall furnish signed copies of the 5-year Warranty for Structural Standing Seam Metal Roof (SSSMR) System, a sample copy of which is attached to this section, [and] the 20-year Manufacturer's Material Warranties, [and the manufacturer's 20-year system weathertightness warranty].

Insulation; [_____].

Certificate attesting that the polyurethane or polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

SD-14 Samples

Accessories; [_____].

One sample of each type of flashing, trim, closure, thermal spacer block, cap and similar items. Size shall be sufficient to show construction and configuration.

Roof Panels; [_____].

One piece of each type to be used, 9 inches long, full width.

Factory Color Finish; [_____].

Three 3 by 5 inches samples of each type and color.

Fasteners; [_____].

Two samples of each type to be used, with statement regarding intended use. If so requested, random samples of bolts, nuts, and washers as delivered to the job site shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

Insulation; [_____].

One piece, 12 by 12 inches, of each type and thickness to be used, with a label indicating the rated permeance (if faced) and R-values. The flame spread, and smoke developed rating shall be shown on the label or provided in a letter of certification.

Gaskets and Insulating Compounds; [_____].

Two samples of each type to be used and descriptive data.

Sealant; [_____].

One sample, approximately 1 pound, and descriptive data.

Concealed Anchor Clips; [_____].

Two samples of each type used.

Subpurlins; [_____].

One piece, 9 inches long.

EPDM Rubber Boots; [_____].

One piece of each type.

1.6 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials shall be covered with weathertight coverings and kept dry. Storage conditions shall provide good air circulation and protection from surface staining.

1.7 WARRANTIES

The SSSMR system shall be warranted as outlined below. Any emergency temporary repairs conducted by the owner shall not negate the warranties.

1.7.1 Contractor's Weathertightness Warranty

The SSSMR system shall be warranted by the Contractor on a no penal sum basis for a period of five years against material and workmanship deficiencies; system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks, and wind uplift damage. The SSSMR system covered under this warranty shall include the entire roofing system including, but not limited to, the standing seam metal roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with ASTM E 1592. In addition, the system shall consist of panel finishes, slip sheet, insulation, vapor retarder, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, curbs, and skylights; interior or exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system; and items specified in other sections of these specifications that are part of the SSSMR system. All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate resistance to specified design loads, water leaks and wind uplift damage shall be repaired as approved by the Contracting Officer. See the attached Contractor's required warranty for issue resolution of warrantable defects. This warranty shall warrant and cover the entire cost of repair or replacement, including all material, labor, and related markups. The Contractor shall supplement this warranty with written warranties from the installer and system manufacturer, which shall be submitted along with Contractor's warranty; however, the Contractor shall be ultimately responsible for this warranty. The Contractor's written warranty shall be as outlined in attached WARRANTY FOR STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM, and shall start upon final acceptance of the facility. It is required that the Contractor provide a separate bond in an amount equal to the installed total roofing system cost in favor of the owner (Government) covering the Contractor's warranty responsibilities effective throughout the five year Contractor's warranty period for the entire SSSMR system as outlined above.

1.7.2 Manufacturer's Material Warranties.

****

NOTE: The 20-year system weathertightness warranty, required in paragraph c. below, will increase construction cost, and should be used only after consultation with the customer. Remove paragraph c. below, if not required in the project.

****

The Contractor shall furnish, in writing, the following manufacturer's material warranties which cover all SSSMR system components such as roof panels, anchor clips and fasteners, flashing, accessories, and trim, fabricated from coil material:

a. A manufacturer's 20 year material warranty warranting that the aluminum, zinc-coated steel, aluminum-zinc alloy coated steel or aluminum-coated steel as specified herein will not rupture, structurally fail, fracture, deteriorate, or become perforated under normal design atmospheric conditions and service design loads. Liability under this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated, or structurally failed coil material.

b. A manufacturer's 20 year exterior material finish warranty on the factory colored finish warranting that the finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of eight, as determined by ASTM D 4214 test procedures; or change color in excess of five CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. Liability under this warranty is exclusively limited to refinishing with an air-drying version of the specified finish or replacing the defective coated material.

c. A roofing system manufacturer's 20 year system weathertightness warranty.

1.8 COORDINATION MEETING

A coordination meeting shall be held within 45 days after contract award for mutual understanding of the Structural Standing Seam Metal Roof (SSSMR) System contract requirements. This meeting shall take place at the building site and shall include representatives from the Contractor, the roof system manufacturer, the roofing supplier, the erector, the designer, and the Contracting Officer. All items required by paragraph SUBMITTALS shall be discussed, including applicable standard manufacturer shop drawings, and the approval process. The Contractor shall coordinate time and arrangements for the meeting.

PART 2 PRODUCTS

2.1 ROOF PANELS

****

NOTE: See TI 809-29 for guidance on roof slope and height of seams.

****

Panels shall be [steel] [aluminum] and shall have a [factory color] [mill] finish. Length of sheets shall be sufficient to cover the entire length of any unbroken roof slope for slope lengths that do not exceed 30 feet. When length of run exceeds 30 feet and panel laps are provided, each sheet in the run shall extend over three or more supports. Sheets longer than 100 feet may be furnished if approved by the Contracting Officer. Width of sheets shall provide not more than 24 inches of coverage in place. SSSMR system with roofing panels greater than 12 inches in width shall have standing seams rolled during installation by an electrically driven seaming machine. Height of standing seams shall be not less than [_____] inches for rolled seam and [_____] inches for seams that are not rolled.

2.1.1 Steel Panels

****

NOTE: When a factory color finish is specified, remove last two sentences from this paragraph. AZ 50 coating is allowed for factory-color-finish and not for mill finish. Remove this paragraph when steel panels are not used in the project.

****

Steel panels shall be zinc-coated steel conforming to ASTM A 653/A 653M; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M, AZ [55] [50] coating; or aluminum-coated steel conforming to ASTM A 463/A 463M, Type 2, coating designation T2 65. Uncoated panels shall be 0.0239 inch thick minimum. Panels shall be within 95 percent of nominal thickness. Prior to shipment, mill finish panels shall be treated with a passivating chemical to inhibit the formation of oxide corrosion products. Panels that have become wet during shipment and have started to oxidize shall be rejected.

2.1.2 Aluminum Panels

****

NOTE: Remove this paragraph when aluminum panels are not used in the project.

****

Alloy conforming to ASTM B 209, temper as required for the forming operation, minimum 0.032 inch thick.

2.2 CONCEALED ANCHOR CLIPS

Concealed anchor clips shall be the same as the tested roofing system. Clip bases shall have factory punched or drilled holes for attachment. Clips shall be made from multiple pieces with the allowance for the total thermal movement required to take place within the clip. Single piece clips may be acceptable when the manufacturer can substantiate that the system can accommodate the thermal cyclic movement under sustained live or snow loads.

2.3 ACCESSORIES

****

NOTE: Select either die cast metal closures or molded closure strips as appropriate.

****

Flashing, trim, metal closure strips, caps and similar metal accessories shall be the manufacturer's standard products. Exposed metal accessories shall be finished to match the panels furnished. [Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chloride premolded to match configuration of the panels and shall not absorb or retain water.] [Die cast metal closures shall be installed with double bead tape sealant and fasteners that stitch the panel to a 16 gage preformed backer plate to ensure a positive compression of the tape sealant.] The use of a continuous angle butted to the panel ends to form a closure will not be allowed.

2.4 FASTENERS

****

NOTE: Fasteners that are not color coated may be limited to 400-series corrosion resisting steel when justified by atmospheric exposure conditions.

****

Fasteners for steel roof panels shall be zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for aluminum roof panels shall be aluminum or corrosion resisting steel. Fasteners for structural connections shall provide both tensile and shear ultimate strengths of not less than 750 pounds per fastener. Fasteners for accessories shall be the manufacturer's standard. Exposed roof fasteners shall be sealed or have sealed washers on the exterior side of the roof to waterproof the fastener penetration. Washer material shall be compatible with the roofing; have a minimum diameter of 3/8 inch for structural connections; and gasketed portion of fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 1/8 inch thick. Exposed fasteners for factory color finished panels shall be factory finished to match the color of the panels.

2.4.1 Screws

Screws for attaching anchor devices shall be not less than No. 14. Actual screw pull out test results shall be performed for the actual material gage and yield strength of the structural purlins or subpurlins to which the clip is to be anchored/attached. Other screws shall be as recommended by the manufacturer to meet the strength design requirements of the panels.

2.4.2 Bolts

Bolts shall be not less than 1/4 inch diameter, shouldered or plain shank as required, with locking washers and nuts.

2.4.3 Structural Blind Fasteners

Blind screw-type expandable fasteners shall be not less than 1/4 inch diameter. Blind (pop) rivets shall be not less than 9/32 inch minimum diameter.

2.5 SUBPURLINS

Cold formed supporting structural members/subpurlins shall have a minimum thickness of 0.059 inches and a minimum tensile yield strength of 50000 psi. Hot rolled structural members shall have a minimum thickness of 0.25 inches and a minimum tensile yield strength of 36000 psi. Subpurlins shall be [galvanized] [shop painted].

2.6 FACTORY COLOR FINISH

****

NOTE: Factory color finish will be specified except when the buildings are to be used for temporary purposes or where mill finish aluminum panels provide an acceptable appearance. If factory color finish is not required, document the rationale for the decision in the design analysis and remove this paragraph.

The U.S. metal building industry offers a variety of color finishes to protect the metal panels against chemical corrosion and ultraviolet radiation; to provide long life with minimum maintenance plus acceptable weathering and color retention; and to assure chalk, fade, and mar resistance. Some of the

most widely used coatings include, but are not limited to, the following:

a. Polyvinylidene fluoride (PVF2); a nominal 0.025 mm (1 mil) thick coating modified with a proprietary resin for toughness; it may be used in most environments.

b. Silicone-modified polyester (SMP); a thermoset coating system composed of polyester resin modified by copolymerization with a functional silicone resin intermediate designed for added protection against chemical corrosion and ultraviolet radiation.

c. Plastisol (PVC); a two-coat system consisting of a polyvinyl-chloride resin dispersed in a plasticizer top-coat over a corrosion-resistant primer; it is a high-performance, thick coating designed for highly aggressive and corrosive environments with excellent resistance to common acids, alkalis, and inorganic compounds.

Most coatings may be ordered extra-thick for buildings in direct contact with salt or chemical laden air or where a premium finish would be justified. The thicker coating provides additional primer and increases the coating's corrosion and abrasion resistance but it requires a special run by the coil coater, at least a 22 degrees C (70 degrees F) environment, and additional delivery time. Appropriate specification requirements must be added if the thick film coatings are to be used.

The high cost of preventing corrosion of galvanized steel panels, together with the fact that cut edges, scratches and penetrations of the panels expose the steel substrate, warrants consideration for the use of solid aluminum which is inherently less susceptible to damaging corrosion.

Roof panels are available in several standard colors. Standard trim colors are usually more limited. Except where interior surfaces receive a factory color coat, the exposed reverse side of the panels normally are provided with an off-white backer coating. Color other than manufacturer's standard colors will be used only when the extra cost is justified.

The choice of coating for the interior face of panels depends on environmental and aesthetic considerations. Where a corrosive atmosphere is anticipated within the structure, the finish should be PVF2 in a thickness appropriate to the

environment. For utilitarian facilities with little likelihood of a detrimental atmosphere, a standard backer coat is appropriate. Backer coat is the manufacturer's standard coating (usually polyester based) applied to the back side of the metal panel. This coating is normally a wash coating and is not controlled for consistent color or gloss. Where interior surfaces are concealed behind insulation, liner panels, etc.; provide only a primer coat. These finishes should not be confused with a wash coat which is used primarily to facilitate the coil forming process and which is not closely controlled for color, gloss or film thickness. The designer's rationale for using any special interior finish should be reflected in the design analysis.

Energy considerations must be included in the choice of standard colors for the roof panels. White or light-colored roofing surfaces are much better at reflecting sunlight than darker surfaces. This keeps roofs 20 to 35 degrees C (35 to 60 degrees F) cooler, which means less heat will be transferred to internal building spaces. Demonstration projects have shown that cooling energy use can be cut by as much as 40 percent when light-colored surfaces are used. Coordinate the use of light-colored roofing material with the user.

****

Panels shall have a factory applied [polyvinylidene fluoride] [_____] finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. Color shall match the color indicated [on the drawings] [in Section 09915 COLOR SCHEDULE]. The exterior coating shall be a nominal [1] [2] mil thickness consisting of a topcoat of not less than 0.7 mil dry film thickness and the paint manufacturer's recommended primer of not less than [0.2] [1.0] mil thickness. The interior color finish shall consist of [the same coating and dry film thickness as the exterior] [a nominal 1 mil thick [PVF2] [_____] finish otherwise the same as the exterior] [a backer coat with a dry film thickness of 0.5 mil] [a 0.2 mil thick prime coat]. The exterior color finish shall meet the test requirements specified below.

2.6.1 Salt Spray Test

****

NOTE: The results of the salt spray test will vary depending on the thickness of the coating.

****

A sample of the sheets shall withstand a cyclic corrosion test for a minimum of 2016 hours in accordance with ASTM D 5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 10, no blistering, as determined by ASTM D 714; 10, no rusting, as determined by ASTM D 610; and a rating of 6, over 2 1/16 to 1/8 inch failure at scribe, as determined by ASTM D 1654.

2.6.2   Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 1/8 inch diameter mandrel, the coating film shall show no evidence of cracking to the naked eye.

2.6.3   Accelerated Weathering, Chalking Resistance and Color Change

****
NOTE: Low gloss finishes have relatively poor weathering qualities. Delete the last sentence if a low gross finish is not required by Paragraph Specular Gloss.
****

A sample of the sheets shall be tested in accordance with ASTM D 4587, test condition [B] [D] for [_____] total hours. The coating shall withstand the weathering test without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with tape in accordance with ASTM D 3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. For sheets required to have a low gloss finish, the chalk rating shall be not less than No. 6 and the color difference shall be not greater than 7 units.

2.6.4   Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

2.6.5   Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 0.500 inch diameter hemispherical head indenter, equal to 1.5 times the metal thickness in mils, expressed in inch-pounds, with no cracking.

2.6.6   Abrasion Resistance Test

****
NOTE: The 70 percent polyvinylidene fluoride finish has a minimum abrasion resistance of about 65 liters per 0.025 mm (65 liters/mil) of coating thickness.

The nominal 0.025 mm (1 mil) finish will withstand 50 to 60 liters of sand while the nominal 0.050 mm (2 mil) finish can be expected to withstand 80-100 liters. The results of this test are variable and offer poor repeatability. In shop drawing review, notice the difference between the specified total liters of sand and those reported.
****

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of [50] [80] liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

2.6.7 Specular Gloss

****

NOTE: Few manufacturers regularly produce prefinished panels meeting these low gloss requirements and such sheets are available only in limited colors. Standard 70 percent PVF2 finish, for example, has a medium gloss. Low gloss paint formulations result in reduced weathering properties. Identify individual facilities requiring low gloss finish.

For roof of structures at airfields where glare would be objectionable and may be an operational hazard, the specular gloss value should be limited to 10 or less at an angle of 85 degrees.

****

Finished roof surfaces for [_____] shall have a specular gloss value of [10 or less at an angle of 85 degrees] [30 plus or minus [_____] at 60 degrees] when measured in accordance with ASTM D 523.

2.6.8 Pollution Resistance

Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

2.7 INSULATION

****

NOTE: Drawings will show type, R-Value, vapor barrier, extent and location of insulation, including insulation retainer system. Insulation retainer system consists of a grid of bands and cross bands and their connections to hold the insulation neatly in place and against the bottom of the roof panels to ensure condensation does not occur. The insulation retainer system will be detailed on the drawings and specified to allow a practical installation. On warehouse, shop or other storage type facilities, where esthetics is not essential, insulation baskets or poultry netting and their connections may be shown and specified for the insulation retainer system. The insulation location is dependent upon the use or absence of a separate roof deck. The vapor retarder location is dependent on the climate as noted in paragraph VAPOR RETARDER.

The required R-value for the insulation will be

determined and shown at the appropriate details on the drawings. The required R-values for the insulation will never be less than the R-values used in the Energy Budget Analysis. The R-values shown on the drawings should be greater than those used in the design analysis to account for thermal bridges. Provide about a one-third increase (or as local experience has shown, if different) in R-value over what is calculated; that is, if an R-value of 3 is needed in metric (metric units are square meter K/W) (16 in I-P with units of h x square feet x degree F/Btu) use an R-value of 4 (21) in the contract. If an analysis of thermal bridges in the design gives a requirement greater or less than this, it should be used.

Flame spread and smoke development ratings of exposed insulation, to include facing, shall comply with the requirements of MIL-HDBK 1008C. Exposed insulation will be faced, mineral fiber type, only; cellular plastic insulations will not be exposed.
****

Thermal resistance of insulation shall be not less than the R-values shown on the contract drawings. R-values shall be determined at a mean temperature of 75 degrees F in accordance with ASTM C 518. Insulation shall be a standard product with the insulation manufacturer, factory marked or identified with insulation manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. [Blanket insulation shall have a facing as specified in paragraph VAPOR RETARDER]. Insulation [, including facings,] shall have a flame spread not in excess of [_____] and a smoke developed rating not in excess of [_____] when tested in accordance with ASTM E 84. The stated R-value of the insulation shall be certified by an independent Registered Professional Engineer if tests are conducted in the insulation manufacturer's laboratory.

2.7.1 Polyisocyanurate Rigid Board Insulation for Use Above a Roof Deck

Polyisocyanurate insulation shall conform to ASTM C 1289, Type II, (having a minimum recovered material content of 9 percent by weight of core material in the polyisocyanurate portion). For polyisocyanurate, the maximum design R-value per 1 inch of insulation used shall be 7.2. Facings shall be non-asphaltic, glass fiber reinforced.

2.7.2 Blanket Insulation

****
NOTE: The specified blanket insulation is a flexible mineral fiber insulation for use at temperatures up to 176 degrees C (350 degrees F).
****

Blanket insulation shall conform to ASTM C 991.

2.7.3 Glass Mat Gypsum Roof Board

Glass mat gypsum roof board for use above the deck or insulation for thermal protection shall have a flame spread - 0, smoke developed - 0, shall be water resistant and have a compressive strength of 500 psi. Glass mat gypsum roof board shall conform to ASTM C 1177/C 1177M.

2.8 INSULATION RETAINERS

Insulation retainers shall be type, size, and design necessary to adequately hold the insulation and to provide a neat appearance. Metallic retaining members shall be nonferrous or have a nonferrous coating. Nonmetallic retaining members, including adhesives used in conjunction with mechanical retainers or at insulation seams, shall have a fire resistance classification not less than that permitted for the insulation.

2.9 SEALANT

Sealants shall be elastomeric type containing no oil or asphalt. Exposed sealant shall be [colored to match the applicable building color] [clear] and shall cure to a rubberlike consistency. Sealant placed in the roof panel standing seam ribs shall be provided in accordance with the manufacturer's recommendations.

2.10 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

2.11 VAPOR RETARDER

****

NOTE: The term vapor retarder has been selected to describe the membrane used to reduce moisture vapor transmission. The location of the vapor retarder is determined by the climate and the building type.

The vapor retarder goes on the side of the insulation with the greatest vapor pressure during the course of the year; therefore, it goes on the outside in a climate predominately warm, and on the inside in a climate predominately cool. The designer should determine the most appropriate application/installation of the vapor retarder based on project circumstances and the intended use of the facility. See TM 5-810-1 for humid climate definition.

Detail the use of insulation on the drawings. The four systems are as follows:

a. Cool climate, no roof deck. The vapor retarder will be a facing on the bottom of blanket insulation.

b. Warm climate, no roof deck. The vapor retarder will be a facing on the top of blanket insulation with a separate insulation support system. A slip sheet is required. If the integral facing is used

to support the insulation, a separate polyethylene vapor retarder must be laid over the insulation.

c. Cool climate, with a roof deck. The vapor retarder will be a separate membrane directly on top of the roof deck with board insulation over the vapor retarder and an unfaced blanket cushioning between the board insulation and the roofing.

d. Warm climate, with a roof deck. The vapor retarder will be a facing on the top of a blanket insulation above board insulation. The board insulation sits on the roof deck. A slip sheet is required.

Unreinforced foil as the facing in conditions b. and d. above, should not be used.
****

2.11.1 Vapor Retarders as Integral Facing

Insulation facing shall have a permeability of [0.1] [0.02] [_____] perm or less when tested in accordance with ASTM E 96. Facing shall be [white] [gray] [green] [of reinforced foil with a vinyl finish] [sheet vinyl] [; except that unreinforced foil with a natural finish may be used in concealed locations]. Facings and finishes shall be factory applied.

2.11.2 Vapor Retarders Separate from Insulation

****
NOTE: Roof deck should not be assumed to function as a vapor retarder.
****

Vapor retarder material shall be polyethylene sheeting conforming to ASTM D 4397. A single ply of 10 mil polyethylene sheet; or, at the Contractor's option, a double ply of 6 mil polyethylene sheet shall be used. A fully compatible polyethylene tape which has equal or better water vapor control characteristics than the vapor retarder material shall be provided. A cloth industrial duct tape in a utility grade shall also be provided to use as needed to protect the vapor retarder from puncturing.

2.11.3 Slip Sheet for Use With Vapor Retarder

****
NOTE: A slip sheet is required to separate the roofing panels from the insulation facing where the facing would be in direct contact with the roofing panels.
****

Slip sheet for use with vapor retarder shall be a 5 lb. per 100 square feet rosin-sized, unsaturated building paper.

2.12 EPDM RUBBER BOOTS

Flashing devices around pipe penetrations shall be flexible, one-piece devices molded from weather-resistant EPDM rubber. Rubber boot material shall be as recommended by the manufacturer. The boots shall have base rings made of aluminum or corrosion resisting steel that conform to the contours of the roof panel to form a weather-tight seal.

2.13 PREFABRICATED CURBS AND EQUIPMENT SUPPORTS

Prefabricated curbs and equipment supports shall be of structural quality, hot-dipped galvanized or galvanized sheet steel, factory primed and prepared for painting with mitered and welded joints. Integral base plates and water diverter crickets shall be provided. Minimum height of curb shall be 8 inches above finish roof. Curbs shall be constructed to match roof slope and to provide a level top surface for mounting of equipment. Curb flange shall be constructed to match configuration of roof panels. Curb size shall be coordinated, prior to curb fabrication, with the mechanical equipment to be supported. Strength requirements for equipment supports shall be coordinated to include all anticipated loads. Flashings shall not be rigidly attached to underline structure.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be in accordance with the manufacturer's erection instructions and drawings. Dissimilar materials which are not compatible when contacting each other shall be insulated by means of gaskets or insulating compounds. Molded closure strips shall be installed wherever roofing sheets terminate in open-end configurations, exclusive of flashings. The closure strip installation shall be weather-tight and sealed. Screws shall be installed with a clutching screw gun, to assure screws are not stripped. Field test shall be conducted on each gun prior to starting installation and periodically thereafter to assure it is adjusted properly to install particular type and size of screw as recommended by manufacturer's literature. Improper or mislocated drill holes shall be plugged with an oversize screw fastener and gasketed washer; however, sheets with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces and edges shall be kept clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Stained, discolored, or damaged sheets shall be removed from the site.

3.1.1 Field Forming of Panels for Unique Area

When roofing panels are formed from factory-color-finished steel coils at the project site, the same care and quality control measures that are taken in shop forming of roofing panels shall be observed. Rollformer shall be operated by the metal roofing manufacturer's representative. In cold weather conditions, preheating of the steel coils to be field formed shall be performed as necessary just prior to the rolling operations.

3.1.2 Subpurlins

Unless otherwise shown, subpurlins shall be anchored to the purlins or other structural framing members with bolts or screws. Attachment to the substrate (when provided) or to the panels is not permitted. The subpurlin spacing shall not exceed 30 inches on centers at the corner, edge and ridge zones, and 5 foot maximum on centers for the remainder of the roof. Corner, edge, and ridge zones are as defined in ASCE 7.

3.1.3 Roof Panel Installation

Roof panels shall be installed with the standing seams in the direction of the roof slope. The side seam connections for installed panels shall be completed at the end of each day's work. Method of applying joint sealant shall conform to the manufacturer's recommendation to achieve a complete weather-tight installation. End laps of panels shall be provided in accordance with the manufacturer's instructions. Closures, flashings, EPDM rubber boots, roof curbs, and related accessories shall be installed according to the manufacturer's drawings. Fasteners shall not puncture roofing sheets except as provided for in the manufacturer's instructions for erection and installation. Expansion joints for the standing seam roof system shall be installed at locations indicated on the contract drawings and other locations indicated on the manufacturer's drawings.

3.1.4 Concealed Anchor Clips

Concealed anchor clips shall be fastened directly to the structural framing members. Attachment to the substrate (when provided) or to the metal deck is not permitted. The maximum distance, parallel to the seams, between clips shall be 30 inches on center at the corner, edge, and ridge zones, and 5 feet maximum on centers for the remainder of the roof.

3.2 INSULATION INSTALLATION

****

NOTE: Choose one paragraph and delete the other. Use rigid or semirigid board insulation with a roof deck. Use blanket insulation without a roof deck. A maximum of 100 mm (4 inches) of batt insulation may be compressed at purlins. Thermal blocks should be shown where required for thermal efficiency. When thermal blocks are shown, a maximum of 50 mm (2 inches) of batt insulation may be compressed at purlins.

****

Insulation shall be continuous over entire roof surface. Where expansion joints, terminations, and other connections are made, the cavity shall be filled with batt insulation with vapor retarder providing equivalent R-value and perm rating as remaining insulation. Insulation shall be installed as indicated and in accordance with manufacturer's instructions.

3.2.1 Board Insulation with Blanket Insulation

Rigid or semirigid board insulation shall be laid in close contact. Board shall be attached to the metal roof deck with bearing plates and fasteners, as recommended by the insulation manufacturer, so that the insulation joints are held tight against each other, and shall have a minimum of 1 fastener per 4 square feet. Layout and joint pattern of insulation and fasteners shall be indicated on the shop drawings. If more than one layer of insulation is required, joints in the second layer shall be offset from joints in the first layer. A layer of blanket insulation shall be placed over the rigid or semirigid board insulation to be compressed against the underside of the metal roofing to reduce thermal bridging, dampen noise, and prevent roofing flutter. This layer of blanket insulation shall be compressed a minimum of 50 percent.

3.2.2 Blanket Insulation

Blanket insulation shall be installed between and parallel to the purlins with tabs of a facer lapping on the top face of the purlins. Thermal blocks shall be provided over purlins, between clips. A second layer of unfaced insulation shall be added between purlins to provide full R-value. Blanket insulation shall be supported by an integral facing or other commercially available support system.

3.3 PROTECTION OF VAPOR RETARDER FROM ROOF DECK

****

NOTE: Delete this paragraph if the vapor retarder will not be in direct contact with the roof deck.

****

A cloth industrial duct tape shall be applied over the seams of metal roof decks, at penetration edges, and at surface areas exhibiting sharp burrs or similar protrusions. For other types of roof decks, cloth industrial duct tape shall be applied over irregularities which could potentially puncture polyethylene membrane.

3.4 VAPOR RETARDER INSTALLATION

****

NOTE: Choose one paragraph and delete the other.

****

3.4.1 Integral Facing on Blanket Insulation

Integral facing on blanket insulation shall have the facing lapped and sealed with a compatible tape to provide a vapor tight membrane.

3.4.2 Polyethylene Vapor Retarder

The polyethylene vapor retarder membrane shall be installed over the entire surface. A fully compatible polyethylene tape shall be used to seal the edges of the sheets to provide a vapor tight membrane. Sheet edges shall be lapped not less than 6 inches. Sufficient material shall be provided to avoid inducing stresses in the sheets due to stretching or binding. All tears or punctures that are visible in the finished surface at any time during the construction process shall be sealed with polyethylene tape.

3.5 SLIP SHEET INSTALLATION

****

NOTE: Delete this paragraph if no blanket insulation facing will be compressed against metal roofing.

****

A slip sheet shall be laid over the blanket insulation facing to prevent the vinyl facing from adhering to the metal roofing.

3.6 CLEANING AND TOUCH-UP

Exposed SSSMR systems shall be cleaned at completion of installation. Debris that could cause discoloration and harm to the panels, flashings, closures and other accessories shall be removed. Grease and oil films, excess sealants, and handling marks shall be removed and the work shall be scrubbed clean. Exposed metal surfaces shall be free of dents, creases, waves, scratch marks, and solder or weld marks. Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire brushed and touched up with the same material used for the shop coat. Factory color finished surfaces shall be touched up with the manufacturer's recommended touch up paint.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM

FACILITY DESCRIPTION____

BUILDING NUMBER:____

CORPS OF ENGINEERS CONTRACT NUMBER:_________________________________

CONTRACTOR

CONTRACTOR:____

ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

OWNER

OWNER:____

ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

CONSTRUCTION AGENT

CONSTRUCTION AGENT:____

ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM
(continued)

THE SSSMR SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY _____________________________ FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE. THE SSSMR SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE, BUT SHALL NOT BE LIMITED TO, THE FOLLOWING: THE ENTIRE ROOFING SYSTEM, MANUFACTURER SUPPLIED FRAMING AND STRUCTURAL MEMBERS, METAL ROOF PANELS, FASTENERS, CONNECTORS, ROOF SECUREMENT COMPONENTS, AND ASSEMBLIES TESTED AND APPROVED IN ACCORDANCE WITH ASTM E 1592. IN ADDITION, THE SYSTEM PANEL FINISHES, SLIP SHEET, INSULATION, VAPOR RETARDER, ALL ACCESSORIES, COMPONENTS, AND TRIM AND ALL CONNECTIONS ARE INCLUDED. THIS INCLUDES ROOF PENETRATION ITEMS SUCH AS VENTS, CURBS, SKYLIGHTS; INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS; EAVES, RIDGE, HIP, VALLEY, RAKE, GABLE, WALL, OR OTHER ROOF SYSTEM FLASHINGS INSTALLED AND ANY OTHER COMPONENTS SPECIFIED WITHIN THIS CONTRACT TO PROVIDE A WEATHERTIGHT ROOF SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THE SPECIFICATIONS THAT ARE PART OF THE SSSMR SYSTEM.

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE ASSOCIATED WITH THE SSSMR SYSTEM COVERED UNDER THIS WARRANTY SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON ____________________________ AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

____
(Company President)   (Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM
(continued)

THE CONTRACTOR SHALL SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE SSSMR SYSTEM, WHICH SHALL BE SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR WILL BE ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY EXAMPLE.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE SSSMR SYSTEM DUE TO ACTIONS BY THE OWNER TO INHIBIT FREE DRAINAGE OF WATER FROM THE ROOF AND GUTTERS AND DOWNSPOUTS OR ALLOW PONDING WATER TO COLLECT ON THE ROOF SURFACE. CONTRACTOR'S DESIGN SHALL INSURE FREE DRAINAGE FROM THE ROOF AND NOT ALLOW PONDING WATER.

6. THIS WARRANTY APPLIES TO THE SSSMR SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR; AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES.

**

**REPORTS OF LEAKS AND SSSMR SYSTEM DEFICIENCIES SHALL BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE, BY TELEPHONE OR IN WRITING, FROM EITHER THE OWNER OR CONTRACTING OFFICER. EMERGENCY REPAIRS TO PREVENT FURTHER ROOF LEAKS SHALL BE INITIATED IMMEDIATELY; A WRITTEN PLAN SHALL BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS SSSMR SYSTEM WITHIN SEVEN (7) CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT SHALL BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE SSSMR SYSTEM REPAIRED OR REPLACED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR.

IN THE EVENT THE CONTRACTOR DISPUTES THE EXISTENCE OF A WARRANTABLE DEFECT, THE CONTRACTOR MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. THE REQUEST FOR AN ARBITRATOR MUST BE MADE WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED, THE PARTIES SHALL, WITHIN TEN (10) DAYS, JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES SHALL CONFER WITHIN TEN (10) DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE (1) NAME REMAINS. THE REMAINING PERSON SHALL BE THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED, ETC., SHALL BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT SHALL PAY FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. A WRITTEN ARBITRATOR'S DECISION WILL BE REQUESTED NOT LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT.

A FRAMED COPY OF THIS WARRANTY SHALL BE POSTED IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

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DEPARTMENT OF THE ARMY	**CEGS-07510 (August 1996)**
U.S. ARMY CORPS OF ENGINEERS	**------------------------**
	Superseding
	CEGS-07510 (February 1993)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 4 (September 1999)
Includes Special Change (Tailoring Options) (June 1998)
Includes Text Adjustment Change (Section Reference) (June 1997)

Latest change indicated by CHG tags

****

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SECTION 07510

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08/96

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS

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SECTION 07510

BUILT-UP ROOFING
08/96

****

NOTE: This guide specification covers the requirements for 4-ply, built-up roofing for use over pre-cast gypsum, light weight insulating concrete, structural concrete, wood, and insulation surfaces. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This specification includes tailoring options for asphalt bitumen, coal-tar bitumen, and walkways. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****

NOTE: In new construction, the minimum slope of the roof structural deck should be 21 mm per m (1/4 inch per foot). For all Army projects, the finished roof membrane should slope a minimum of 21 mm per m (1/4 inch per foot). Higher slopes will be determined by local environmental conditions and experience. Roof slopes should be obtained by sloping the structural members in lieu of the use of moisture-bearing lightweight fills, asphaltic dry fills, or tapered board-type insulations. Direction and degree of slope should be indicated on the roof drawings. Where roof slopes are greater than 42 mm per m (1/2 inch per foot) the use of mechanical fastening will be required for felt piles and this section will be revised accordingly.

Coal-tar bitumen is not permitted for slopes exceeding 21 mm per m (1/4 inch per foot).

Data from roofing manufacturers, Factory Mutual and Underwriters Laboratories should be consulted for recommendations on roof system attachment in areas where high winds have caused roof damage.

Wood nailers are specified in Section 07220 ROOF INSULATION and should be included in this section if roofing is specified without board-type insulation or underlayment.

Expansion joints in the roofing should be located at high points where practicable, and placed on curbs above the water line. Expansion joints shall be provided as follows:

(a) at each expansion joint in the structure;

(b) uniformly spaced at intervals not over 60 m (200 feet) in length or width;

(c) at each intersection where an "L" or "T" shaped roof deck changes direction;

(d) at each change of deck material.

The relative position of insulation and roof deck components should be in accordance with TM 5-805-14.

Proper venting of structural concrete and lightweight insulating concrete is mandatory to assure relief of moisture vapor pressure.
****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 208	(1995) Cellulosic Fiber Insulating Board
ASTM C 728	(1997) Perlite Thermal Insulation Board
ASTM C 1153	(1997) Location of Wet Insulation in Roofing Systems Using Infrared Imaging
ASTM C 1177/C 1177M	(1996) Glass Mat Gypsum Substrate for Use as Sheathing
ASTM D 41	(1994) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 43	(1994) Coal Tar Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 226	(1997a) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 227	(1998) Coal-Tar Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 312	(1995a) Asphalt Used in Roofing
ASTM D 450	(1996) Coal-Tar Pitch Used in Roofing, Dampproofing, and Waterproofing
ASTM D 517	(1992) Asphalt Plank
ASTM D 1668	(1997a) Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
ASTM D 1863	(1993; R 1996) Mineral Aggregate Used on Built-Up Roofs
ASTM D 2178	(1997) Asphalt Glass Felt Used in Roofing and Waterproofing
ASTM D 2626	(1997b) Asphalt-Saturated and Coated Organic Felt Base Sheet Used in Roofing
ASTM D 3617	(1983; R 1994) Sampling and Analysis of New Built-Up Roof Membranes
ASTM D 3909	(1997) Asphalt Roll Roofing (Glass Felt) Surfaced With Mineral Granules

ASTM D 4022	(1994) Coal Tar Roof Cement, Asbestos Containing
ASTM D 4586	(1993) Asphalt Roof Cement, Asbestos Free
ASTM D 4601	(1998) Asphalt-Coated Glass Fiber Base Sheet Used in Roofing
ASTM D 4897	(1998) Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825c	(1998) Approval Guide Building Materials

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Inspection; [_____].

The inspection procedure for roofing installation, prior to the start of roofing work.

SD-13 Certificates

Bitumen; [_____]. Felt; [_____].

Certificates of Compliance for felts and bitumens.

Cants; [_____].

Certificate attesting that the fiberboard furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

1.3 STORAGE OF MATERIALS

Felts, fabrics, and roll roofing shall be kept dry before, during, and after delivery to the site and shall be stored in an enclosed building or in a closed trailer, and stored on end 1 level high. Felt rolls shall be maintained at a temperature above 50 degrees F for 24 hours immediately before laying. Aggregate shall be kept dry as defined by ASTM D 1863.

PART 2   PRODUCTS

2.1   PRIMER

****

NOTE: Delete references to coal-tar bitumen on projects limited to asphalt only. Delete references to asphalt on projects limited to coal-tar only.

****

ASTM D 41 for asphalt roofing systems; ASTM D 43 for coal-tar roofing systems.

2.2   BITUMEN

2.2.1   Asphalt

****

NOTE: Retain the second set of brackets for projects located in Florida, Texas, New Mexico, Arizona and California or where recommended by the roofing manufacturer; delete the first set of brackets for those projects. Use the first set of brackets only for other areas.

****

ASTM D 312, [Type II on slopes from 1/4 inch per foot up to and including 1/2 inch per foot; Type II or Type III on slopes above1/2 inch per foot up to and including 1 inch per foot; Type III on slopes above 1 inch per foot up to and including 3 inches per foot.] [Type III on slopes from 1/4 inch per foot up to and including 3 inches per foot; Type IV on slopes above 3 inches per foot.] Bills of lading shall indicate the flash point and equiviscous temperature (EVT) or this information shall be shown on labels for each container of asphalt.

2.2.2   Coal-Tar Bitumen

ASTM D 450, Type III, for 1/4 inch per foot slope as an option to asphalt.

2.3   BITUMINOUS CEMENT

ASTM D 4586 for use with asphalt roofing systems. ASTM D 4022 for use with coal-tar roofing systems; preference shall be given to cements whose mineral fillers exclude asbestos fibers.

2.4   CANTS

Cants shall be made from [treated wood or treated fiberboard not less than 3-1/2 inches high] [perlite board] cut to reduce change in direction of the membrane to 45 degrees or less. Treated wood shall be of water-borne preservative-treated material as specified in Section 06100ROUGH CARPENTRY. Perlite and fiberboard shall contain the highest practicable percentage of materials which have been recovered or diverted from solid waste (e.g., postconsumer waste), but not including material reused in a manufacturing process. Where two materials have comparable price and performance, the one having the higher recovered material content shall be selected. Fiberboard shall conform to ASTM C 208 with a minimum recovered material content of 80 percent, treated with sizing, wax or bituminous impregnation. Perlite board shall conform to ASTM C 728with a minimum recovered material content of 23 percent of the expanded perlite portion of the board.

2.5 FELT

2.5.1 Base Sheet

Base sheet shall conform to ASTM D 4601, Type II, with no perforations.

2.5.2 Venting Inorganic Base Sheet

ASTM D 4897, Type II.

2.5.3 Glass Roofing Felt

ASTM D 2178, Type IV or VI, except felts for coal tar systems shall be impregnated with a bituminous resin coating which is compatible with coal tar bitumen.

2.5.4 Organic Felt Base

ASTM D 2626 for use with asphalt roofing system.

2.5.5 Organic Felt

ASTM D 226 for use with asphalt roofing system and ASTM D 227 for use with coal-tar roofing system. Organic felts may be used for bitumen stops, and edge envelopes.

2.6 MINERAL-SURFACED ROLL ROOFING

ASTM D 3909.

2.7 NAILS AND FASTENERS

****
NOTE: Delete references to fasteners when they are not required.
****

Nails and fasteners shall be an approved type recommended by the roofing felt manufacturer. Fasteners for steel or concrete deck shall conform to FM P7825c for Class I roof deck construction, to withstand an uplift pressure of [60][90] pounds per square foot.

2.8 AGGREGATE SURFACING MATERIALS

****
NOTE: When it is locally available, light-colored aggregate will be specified.
****

Crushed stone, gravel, or crushed slag conforming to ASTM D 1863. Subject to approval, other materials may be used when blended to the grading requirements of ASTM D 1863. Aggregate shall be light-colored and opaque.

2.9 WALKWAY SURFACES

2.9.1 Mineral Asphalt Plank

ASTM D 517, minimum 3/4 inch thick.

2.9.2 Concrete Slab

Precast Concrete 3000 psi, 12 x 24 x 2-1/2 inches.

2.10 WOVEN GLASS FABRIC

ASTM D 1668, Type I for asphalt roofing systems and Type II for coal-tar roofing systems.

2.11 INSULATION

Insulation shall be fiberboard, composite board, expanded perlite, mineral fiber, or polyisocyanurate, as specified in Section 07220 ROOF INSULATION. Top layer shall be minimum 3/4 inch thick fiberboard, mineral fiber or perlite.

2.12 Glass Mat Gypsum Roof Board

Glass mat gypsum roof board shall be in accordance with ASTM C 1177/C 1177M, flame spread - 0, smoke developed - 0, 500 psi Class A non-combustible. The glass mat gypsum roof board shall be a minimum 1/4 inch thickness.

2.13 FLASHINGS

Bituminous flashings in accordance with these specifications shall be used throughout unless otherwise specified or indicated.

PART 3 EXECUTION

3.1 COORDINATION

The entire roofing system, excluding flood coat and aggregate surfacing, shall be finished in 1 operation up to the line of termination at end of day's work. Glaze coating may be considered part of the flood coat as specified in paragraph GLAZE COAT. Phased construction will not be permitted.

3.1.1 Insulation

Application of roofing shall immediately follow application of insulation as a continuous operation. Roofing operations shall be coordinated with insulation work so that all roof insulation applied each day is waterproofed the same day. Insulation is specified in Section 07220ROOF INSULATION.

3.1.2 Sheet Metalwork

Roofing operations shall be coordinated with sheet metalwork so that sheet metal items are installed to permit continuous roof surfacing operations the same day felts are installed. Sheet metalwork is specified in Section 07600 SHEET METALWORK, GENERAL.

3.2 ENVIRONMENTAL CONDITIONS

Air temperature shall be above 40 degrees F and there shall be no visible ice, frost, or moisture on the roof deck at the time roofing is installed.

3.3 PREPARATION REQUIREMENTS

The substrate construction of a bay or section of the building shall be completed before roofing work is begun thereon. [Roofing applied directly on lightweight insulating concrete shall not be scheduled until the insulating concrete passes the air-dry density test specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.] [Roofing applied directly on concrete shall not be scheduled until frothing or bubbling does not occur when hot bitumen is applied to the concrete and until the hot bitumen sticks tightly to the concrete.] Vents and other items penetrating the roof shall be secured in position and properly prepared for flashing. Nailers, curbs and other items attached to roof surface shall be in place before roofing is begun.

3.4 INSTALLATION OF CANTS

Cants shall be installed in the angles formed between the roof and walls or other vertical surfaces. Cants shall be laid in a solid coat of bituminous cement just prior to laying the roofing plies. Cants shall be continuous, and shall be installed in lengths as long as practicable. Additional cants are not required at locations where cast-in-place cants are integrally formed with the structural deck or roof fill.

3.5 CONDITION OF SURFACES

Surfaces shall be inspected and approved immediately before application of roofing and flashings. The roofing and flashings shall be applied to a smooth and firm surface free from ice, frost, visible moisture, dirt, projections, and foreign materials. Prior to application of primer on precast concrete decks, joints shall be covered with a 4 inch strip of roofing felt, embedded in and coated with bituminous cement.

3.6 MECHANICAL APPLICATION DEVICES

Mechanical application devices shall be mounted on pneumatic-tired wheels, and shall be designed and maintained to operate without damaging the insulation, roofing membrane, or structural components.

3.7 PRIMING

****

NOTE: Remove this paragraph if priming is not required when using coal tar pitch.

****

Concrete surfaces to receive bitumen shall be uniformly coated with primer at a rate of not less than 1 gallon per square and allowed to dry. Primer shall be compatible with the bitumen to be used.

3.8 HEATING OF BITUMEN

****

NOTE: Delete references to coal-tar bitumen on

projects limited to asphalt only. Delete references to asphalt on projects limited to coal-tar only.
****

Asphalt shall not be heated higher than 75 degrees F above the EVT or 50 degrees below the flash point or 525 degrees F (maximum) whichever is lower. EVT and flash point temperatures of asphalt in the kettle shall be conspicuously posted on the kettle. Coal tar bitumen shall not be heated above [425 degrees F.][[_____] as recommended by the roofing manufacturer.] Heating kettles shall be provided with automatic thermostatic controls and an accurate thermometer. Kettle operators shall be in attendance at all times during the heating to ensure that the maximum temperature specified is not exceeded. Equipment utilizing flame-heat shall not be placed on the roof.

3.9   BITUMEN STOPS

Bitumen stops shall be installed at roof edges, openings and vertical projections before application of roofing plies unless otherwise recommended by the manufacturer's printed instructions. Bitumen stops shall be formed of two 18 inch wide strips of organic felt.   Nine inches of the width shall be attached to the roof surface with 9 inches extending beyond the edge. The first strip shall be applied in a 9 inch wide layer of bituminous roofing cement and nailed 1/2 inch from the roof edge at 6 inch spacing. The second strip shall be applied to the first in a 9 inch wide mopping of bitumen. The free portion of each strip shall be protected from damage throughout the roofing period. After the roofing plies are in place, the free portion of each strip shall be folded back over the roofing membrane and embedded in a continuous coating of bituminous cement and secured with roofing nails spaced 3 inches on centers.

3.10   BITUMEN APPLICATION

Asphalt shall be applied within a range of 25 degrees F below to 25 degrees F above the EVT. Temperature of coal-tar bitumen at the time it is applied shall be in accordance with the bitumen manufacturer's recommendations. Application temperatures shall be measured at the mop bucket or mechanical applicator. Bitumen at a temperature below the recommended temperature shall be returned to the kettle. Each layer of felt shall be laid in not less than 20 pounds nor more than 35 pounds of asphalt per square or not less than 30 pounds nor more than 35 pounds of coal-tar bitumen per square. Where solid moppings are required, the following requirements as evidenced in any one roof cut-out sample shall apply:

a. Overlapping voids between two or more plies are not acceptable.

b. The maximum length of any individual void that is encapsulated in bitumen shall be 2 inches.

c. The total length of all voids encapsulated in bitumen shall not exceed 4 inches between any two plies.

d. Dry voids (the absence of bitumen between plies) are not acceptable.

e. Voids continuous through the specimen are not acceptable.

f. Visual interply moisture in voids is not acceptable.

3.11 APPLICATION OF FELTS

****
NOTE: Squeegeeing should replace brooming when glass fiber reinforcing plies are installed with a feltlayer, or on very windy application days when the lighter glass fiber plysheet material may be difficult to set.
****

Felt plies shall be laid at right angles to the slope of the deck with minimum 6 inch end-laps staggered at least 12 inches. Felts shall be applied in 36 inch widths with 24 2/3 inch side laps and starter sheets 12, 24 and 36 inches wide along eaves to maintain 4 full plies including the base sheet when used. The full 36 inch width of each ply shall be placed in hot bitumen immediately behind the applicator. A [squeegee] [broom or follow through tool] shall be used to eliminate air pockets and obtain complete adhesion between plies. Bitumen shall be visible beyond all edges of each ply as it is being installed. Plies shall be laid free of wrinkles, creases or fishmouths. Each layer of roofing felt shall be carried up to the top of the cant. Workers shall not walk on mopped surfaces when the bitumen is fluid. For slopes exceeding 1/2 inch per foot, each felt ply, other than venting base sheet, shall be nailed 2 inches and 6 inches from upper edge with nails spaced 12 inches on centers in each row.

3.11.1 On Gypsum, Lightweight Concrete or Insulating Concrete Surfaces

One ply of venting inorganic base sheet shall be laid, shingle fashion, without mopping and with each sheet lapping 4 inches over the previous sheet. Each base sheet shall be nailed or fastened at 9 inch intervals along laps and shall also be nailed or fastened at 18 inch intervals staggered down the center of the sheet in 2 rows 11 inches apart. Three plies of glass roofing felts shall be immediately placed shingle-fashion in solid mopped bitumen over the base sheet as specified. Felts shall be applied in 36 inch widths with 24 2/3 inch side laps and starter sheets 12, 24 and 36 inches wide along eaves to maintain 3 full plies over the base sheet.

3.11.2 On Concrete or Insulation Surfaces

****
NOTE: For concrete over a continuous metal deck, as in shielded facilities, apply a vented base ply and 3 plies of glass roofing felts as specified for gypsum, lightweight concrete, or insulating concrete.
****

Four plies of 36 inch wide glass roofing felts shall be placed shingle-fashion in solid mopped bitumen.

3.12 MECHANICAL FASTENING

Nails and fasteners for securing roofing shall be flush driven through flat metal disks of not less than 1 inch diameter. Metal disks may be omitted where heads of fasteners are equivalent in size to the 1 inch diameter disks. Fasteners, when required, shall be spaced within 20 percent of the indicated spacing dimensions. There shall be no less than the total number of indicated fasteners in any 100 square feet area. Fastener pull-out resistance shall be not less than 40 pounds each.

3.13 PROTECTION OF APPLIED ROOFING

At end of day's work or whenever precipitation is imminent, the terminated edge of built-up roofing shall be sealed with 2 full width strips of roofing felt set in and coated with bituminous cement. One half-width of the strips shall be extended up and over the finished roofing and the other half-width extended out and onto the bare roof deck. Sealing strips shall be removed before continuing installation of roofing. To facilitate sealing, termination edges may be straightened with pieces of insulation board which shall be removed when work is resumed.

3.14 FLASHINGS

Flashings shall be provided over cants in the angles formed at walls and other vertical surfaces and where required to make the work watertight. Bituminous flashings described below shall be used, except where metal flashings are specified in other sections of the specifications. Flashings shall be provided and installed immediately after the top ply of felt is placed and before the flood coat and aggregate are placed, adjacent to the flashing. Modified bituminous flashing may be used when it is specified in the roofing manufacturer's instructions.

3.14.1 Base Flashings

Base Flashings shall be a 3-ply system using woven glass fabric, laid in roofing cement, with mineral surfaced roll roofing as the outer ply. The top of the base flashing shall be at least 8 inches above the roof membrane surface. Mineral surfaced roofing strips shall be cut from the width of the rolls, and shall extend from the reglet or top of curb onto the roof at least 2 inches beyond the widest flashing ply. Laps shall be well cemented, and where possible, shall be shingled in a direction down slope or away from the prevailing wind. The top edge of base flashing systems shall be nailed a maximum of 8 inches on center.

3.14.2 Strip Flashings

Sheet metal flashings, bitumen stops and gravel stops installed over the roofing top ply shall be strip flashed with 2 layers of roofing felt, 9 inches and 12 inches wide and successively cemented in place.

3.14.3 Valleys and Ridges

Felt plies shall continue across valleys and ridges and terminate approximately 12 inches from the valley or ridge. Exposed lap shall terminate on a line approximately 12 inches from, and parallel to the valley or ridge. Two plies of roofing felt 9 inch wide bottom ply, and 12 inch wide top ply, shall be successively mopped-in over each felt line of termination.

3.15 WALKWAYS

****

NOTE: Show walkways or traffic surfaces on the drawings. Metal grid walkway (for heavy traffic or to elevate walkway above ice and snow) must have design loads and footings specified or shown to assure structural integrity and to protect the roof

membrane.
****

Walkways shall be [mineral-surfaced asphalt planks, back-mopped and embedded in the flood coat prior to aggregate surfacing] [concrete slab,] [metal grid] and shall be located as indicated.

3.16 AGGREGATE SURFACING

After roofing felts have been laid and flashings installed, the roof surface, except for cants, shall be flood-coated uniformly with 60 pounds of hot asphalt per square or [75][70][_____] pounds per square of coal-tar bitumen if coal-tar roof system is used. Aggregate surfacing materials shall be spread on the hot bitumen at a rate of 400 pounds per square for gravel or 300 pounds per square for other approved surfacing aggregate.

3.17 GLAZE COAT

****
NOTE: Edit this paragraph following manufacturer's recommendations for the type of roofing used.
****

[Glaze coating shall be used to waterproof completed sections when more than one day is required to finish the roofing. If there is a probability of rain falling on the felts before the flood coat and aggregate can be applied, a light glaze coat of bitumen 10 to 15 pounds per square, shall be applied over the exposed felts. The surfacing operation shall be completed within 48 hours after application of the glaze coat. Where glaze coat is used, surface treatment shall be completed as soon as weather conditions permit.] [Only valleys and low areas that may pond water shall receive glaze coating for fiber glass ply felts in asphalt bitumen systems when [_____] days are required to finish the roofing.]

3.18 ROOF CUT-OUT TESTS

Roof cut-out samples shall be taken and analyzed in accordance with ASTM D 3617 as directed by the Contracting Officer when there is reason to believe that deficiencies exist in the roofing membrane. When samples indicate deficiencies in the built-up roofing, corrective action shall be taken as directed.

3.19 INSPECTION

****
NOTE: When justified by the amount or criticality of the roofing involved, and when similar requirements are not established for the Contractor Quality Control organization specified elsewhere, the following requirement may be added at the end of the paragraph: A roofing technician responsible directly to the Contractor and experienced in the construction of built-up roofing systems and related work shall perform the inspection functions and be on the site whenever roofing operations are in progress.
****

The Contractor shall establish and maintain an inspection procedure to assure compliance of the installed roofing with the contract requirements. Any work found not to be in compliance with the contract shall be promptly removed and replaced or corrected in an approved manner. Inspection shall include, but not be limited to, the following:

a. Environmental conditions; number and skill level of roofing workers; start and end time of various tasks; condition of substrate.

b. Verification of compliance of materials before, during, and after installation.

c. Inspection of condition of equipment and accuracy of thermometers and metering devices.

d. Inspection of flashings, cants and curbs.

e. Inspection of membrane placement, including edge envelopes, widths of starter sheets, laps, proper use of squeegee, and mechanical fastening.

f. Inspection of application of bitumen, aggregate, and walkways.

g. Inspection of embedment of aggregate for required weight and coverage.

h. Cutout sampling and analysis as directed.

3.20 INFRARED INSPECTION

****

NOTE: Infrared (IR) inspection will add 22 to 54 cents to the cost of each square meter (2 to 5 cents per square foot) of roofing; the cost being higher per square meter (square foot) for smaller jobs. (Costs are based on 1990 data). Therefore, IR inspection should be limited to large scale projects or those of a critical nature.

IR inspection is used to detect the temperature differential between the wet and dry insulation. The survey should be made after at least 8 months of service which must include some wet weather. In dry climates, consider requiring the Contractor to flood the roof to assure absence of leaks.

Differences in temperature are not always due to wet insulation, so test cuts must be made to determine actual moisture content in wet and dry areas. The Contractor must repair wet areas and all sample cutouts.

****

[Eight] [_____] months after completion of the roofing system, the roof surface shall be inspected using infrared (IR) imaging as specified in ASTM

C 1153. Where the IR inspection indicates wet insulation, sample cuts shall be taken (including a sample from a suspected dry area) and the moisture content of insulation shall be determined. Insulation shall be replaced where moisture content exceeds the following values: wood fiber: 30 percent, glass fiber: 25 percent, perlite board: 25 percent, and polyurethane: 60 percent. Wet insulation, overlying roofing and sample-cut areas shall be replaced as directed.

-- End of Section --

****

DEPARTMENT OF THE ARMY **CEGS-07600 (October 1994)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**
Superseding
CEGS-07600 (January 1989)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 3 (December 1997)
Includes Special Change (Tailoring Options) (June 1998)
Includes Text Adjustment Change (Section 01300 Reference) (June 1997)

Latest Notice change indicated by CHG tags

****

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10/94

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SECTION 07600

SHEET METALWORK, GENERAL
10/94

****
NOTE: This guide specification covers the requirements for sheet metalwork for general building construction. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for gutters and downspouts, flashing, and gravel stops and fascia. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.
****

PART 1 GENERAL

****
NOTE: Details of sheet metalwork will be shown on project drawings in accordance with the appropriate details in the Architectural Sheet Metal Manual of

the Sheet Metal and Air Conditioning Contractors National Association.

Coordinate specifications with the drawings so that drawing details and SMACNA-02 requirements do not conflict or repeat. Delete references to SMACNA-02 when requirements are detailed in the drawings.

Sheet metal color will be long lasting such as anodized aluminum, or baked enamel, and will not be painted in the field. This does not preclude the use of natural materials like copper or aluminum when that is the choice of the designer. Avoid use of copper where drainage from the copper will pass over exposed masonry, stonework, or other metal surfaces.

Galvanized steel may be specified for temporary structures or where it may be satisfactory due to climatic conditions. Galvanized steel will not be permitted as an option to other metals specified. Where galvanized steel is specified, changes will be made to the text as follows:

Paragraph REFERENCES Add:

ASTM A 526 (1990) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality

Paragraph MATERIALS Add: Galvanized Steel: ASTM A 526, Coating G90.

Add paragraph LOUVERS: Require louvers to be galvanized steel, with blades riveted and soldered.

Paragraph PROTECTION OF ALUMINUM: Revise to require galvanized steel to be treated the same as aluminum, i.e., separated from copper or protected.

Paragraph CONNECTIONS AND JOINTING: Revise to require galvanized steel to be soldered.

Paragraph EXPANSION JOINTS: Revise to require expansion joints to be spaced at 12.0 m (40 foot) intervals for galvanized steel.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM B 32	(1996) Solder Metal
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B 370	(1992) Copper Sheet and Strip for Building Construction
ASTM D 226	(1997) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 543	(1995) Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D 822	(1996) Conducting Tests on Paint and Related Coatings and Materials Using Filtered Open-Flame Carbon-Arc Exposure Apparatus
ASTM D 828	(1993) Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation-Apparatus
ASTM D 1784	(1996) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2822	(1991; R 1997) Asphalt Roof Cement
ASTM D 3656	(1994) Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
ASTM D 4022	(1994) Coal Tar Roof Cement, Asbestos Containing
ASTM D 4586	(1993) Asphalt Roof Cement, Asbestos Free
ASTM E 96	(1995) Water Vapor Transmission of Materials

INSECT SCREENING WEAVERS ASSOCIATION (ISWA)

ISWA IWS 089	(1990) Recommended Standards and

Specifications for Insect Wire Screening (Wire Fabric)

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

SMACNA-02 (1993; Errata) Architectural Sheet Metal Manual

1.2 GENERAL REQUIREMENTS

Sheet metalwork shall be accomplished to form weathertight construction without waves, warps, buckles, fastening stresses or distortion, and shall allow for expansion and contraction.

1.2.1 Coordination

Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades shall be performed by sheet metal mechanics. Application of bituminous strip flashing over various sheet metal items is covered in Section 07510 BUILT-UP ROOFING. Installation of sheet metal items used in conjunction with roofing shall be coordinated with roofing work to permit continuous roofing operations. Sheet metalwork pertaining to heating, ventilating, and air conditioning is specified in Section [_____].

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Materials; [_____].

Drawings of sheet metal items showing weights, gauges or thicknesses; types of materials; expansion-joint spacing; fabrication details; and installation procedures.

1.4 DELIVERY, STORAGE, AND HANDLING

Materials shall be adequately packaged and protected during shipment and shall be inspected for damage, dampness, and wet-storage stains upon delivery to the jobsite. Materials shall be clearly labeled as to type and manufacturer. Sheet metal items shall be carefully handled to avoid damage. Materials shall be stored in dry, ventilated areas until immediately before installation.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: If material is not specified, Contractor will have a choice of aluminum, copper or stainless steel, as listed in SMACNA-02 and not prohibited herein. If the material is specified, delete this paragraph and delete all other materials listed in this section.

The minimum thicknesses specified in SMACNA-02 may be increased and other materials may be used if justified by local conditions.

If galvanized steel is required for temporary facilities, delete "galvanized steel" from the first sentence below.

****

Lead, lead-coated metal, and galvanized steel shall not be used. Any metal listed by SMACNA-02 for a particular item may be used, unless otherwise specified or indicated. Materials shall conform to the requirements specified below and to the thicknesses and configurations established in SMACNA-02. Different items need not be of the same metal, except that if copper is selected for any exposed item, all exposed items shall be copper.

2.1.1 Accessories

Accessories and other items essential to complete the sheet metal installation, though not specifically indicated or specified, shall be provided.

2.1.2 Aluminum Extrusions

ASTM B 221, Alloy 6063, Temper T5.

2.1.3 Bituminous Cement

Type I asphalt cement conforming to ASTM D 2822 or ASTM D 4586. For coal tar roofing; coal tar cement conforming to ASTM D 4022.

2.1.4 Sealant

Unless otherwise specified, sealant shall be an elastomeric weather resistant sealant as specified in Section 07900 JOINT SEALING.

2.1.5 Fasteners

Fasteners shall be compatible with the fastened material and shall be the type best suited for the application.

2.1.6 Felt

ASTM D 226, Type I.

2.1.7 Polyvinyl Chloride (PVC) Reglets

ASTM D 1784, Class 14333D, 0.075 inch minimum thickness.

2.1.8 Aluminum Alloy Sheet and Plate

ASTM B 209, [anodized [clear] [color [_____]]] [clad], form, alloy, and temper appropriate for use.

2.1.9 Copper

ASTM B 370, Temper H 00.

2.1.10 Stainless Steel

****
NOTE: Finishes are described in SMACNA-02. See ASTM A 480 for other than standard mill finishes.
****

ASTM A 167, Type 302 or 304; fully annealed, dead soft temper.

2.1.11 Solder

ASTM B 32, 95-5 tin-antimony.

2.1.12 Through-Wall Flashing

****
NOTE: Select through-wall flashing material best suited for the project and delete the others.
****

a. Electro-sheet copper not less than 5 ounces, factory coated both sides with acid- and alkali-resistant bituminous compound not less than 6 ounces per square foot or factory covered both sides with asphalt-saturated cotton fabric, asphalt saturated glass-fiber fabric, or with 40 poundreinforced kraft paper bonded with asphalt.

b. Stainless steel, Type 304, not less than 0.003 inch thick, completely encased by and permanently bonded on both sides to 50 pound high strength bituminized crepe kraft paper, using hot asphalt, heat, and pressure.

c. Nonreinforced, waterproof, impermeable extruded elastomeric single ply sheeting not less than 30 mils thick.

d. Three ounce copper sheet, with 2 mils of dense, clear, polyethylene sheet bonded to each side of the copper.

e. Other through-wall flashing material may be used provided the following performance criteria are met.

(1) No cracking or flaking when bent 180 degrees over a 1/32 inch mandrel and rebent at the same point over the same mandrel in an opposite direction at 32 degrees F.

(2) Water vapor permeability not more than 2 perms when tested in accordance with ASTM E 96.

(3) Minimum breaking strength of 90 pounds per inch width in the weakest direction when tested in accordance with ASTM D 828.

(4) No visible deterioration after being subjected to a 400-hour direct weathering test in accordance with ASTM D 822.

(5) No shrinkage in length or width and less than 5 percent loss of breaking strength after a 10-day immersion, per ASTM D 543, in 5 percent (by weight) solutions, respectively, of sulfuric acid, hydrochloric acid, sodium hydroxide or saturated lime (calcium hydroxide).

2.1.13   Louver Screen

[[Type I commercial bronze] [Type II carbon steel] [Type III aluminum alloy] insect screening conforming to ISWA IWS 089] [or] [[Plastic-coated glass fiber mesh] [and] [louver cloth] conforming to ASTM D 3656].

PART 3   EXECUTION

3.1   GENERAL

Items such as <TAI OPT=GUTTERS AND DOWNSPOUTSwith aluminum.

3.2   CONNECTIONS AND JOINTING

3.2.1   Soldering

Soldering shall apply to copper, and stainless steel items. Edges of sheet metal shall be pretinned before soldering is begun. Soldering shall be done slowly with well heated soldering irons so as to thoroughly heat the seams and completely sweat the solder through the full width of the seam. Edges of stainless steel to be pretinned shall be treated with soldering acid flux. Soldering shall follow immediately after application of the flux. Upon completion of soldering, the acid flux residue shall be thoroughly cleaned from the sheet metal with a water solution of washing soda and rinsed with clean water.

3.2.2   Riveting

Joints in aluminum sheets 0.040 inch or less in thickness shall be mechanically made.

3.2.3   Seaming

Flat-lock and soldered-lap seams shall finish not less than 1 inch wide. Unsoldered plain-lap seams shall lap not less than 3 inches unless otherwise specified. Flat seams shall be made in the direction of the flow.

3.3   CLEATS

A continuous cleat shall be provided where indicated or specified to secure loose edges of the sheet metalwork. Butt joints of cleats shall be spaced approximately 1/8 inch apart. The cleat shall be fastened to supporting wood construction with nails evenly spaced not over 12 inches on centers. Where the fastening is to be made to concrete or masonry, screws shall be used and shall be driven in expansion shields set in concrete or masonry.

3.4 GUTTERS AND DOWNSPOUTS

Gutters and downspouts shall be installed as indicated. Gutters shall be supported [as indicated] [by continuous cleats] [and] [or] [by cleats spaced not less than 36 inches apart]. Downspouts shall be rigidly attached to the building. Supports for downspouts shall be spaced according to manufacturer's recommendations.

3.5 FLASHINGS

Flashings shall be installed at locations indicated and as specified below. Sealing shall be according to the flashing manufacturer's recommendations. Flashings shall be installed at intersections of roof with vertical surfaces and at projections through roof, except that flashing for heating and plumbing, including piping, roof, and floor drains, and for electrical conduit projections through roof or walls are specified in other sections. Except as otherwise indicated, counter flashings shall be provided over base flashings. Perforations in flashings made by masonry anchors shall be covered up by an application of bituminous plastic cement at the perforation. Flashing shall be installed on top of joint reinforcement. Flashing shall be formed to direct water to the outside of the system.

3.5.1 Base Flashing

Metal base flashing shall be coordinated with roofing work. Metal base flashing shall be set in plastic bituminous cement over the roofing membrane, nailed to nailing strip, and secured in place on the roof side with nails spaced not more than 3 inches on centers. Metal base flashing shall not be used on built-up roofing.

3.5.2 Counter Flashings

Except as otherwise indicated, counter flashings shall be provided over base flashings. Counter flashing shall be installed as shown [on the drawings] [in SMACNA-02]. Where bituminous base flashings are provided, the counter flashing shall extend down as close as practicable to the top of the cant strip. Counter flashing shall be factory formed to provide spring action against the base flashing.

3.5.3 Stepped Flashing

Stepped flashing shall be installed where sloping roofs surfaced with shingles abut vertical surfaces. Separate pieces of base flashing shall be placed in alternate shingle courses.

3.5.4 Through-Wall Flashing

Through-wall flashing includes sill, lintel, and spandrel flashing. The flashing shall be laid with a layer of mortar above and below the flashing so that the total thickness of the two layers of the mortar and flashing are the same thickness as the regular mortar joints. Flashing shall not extend further into the masonry backup wall than the first mortar joint. Joints in flashing shall be lapped and sealed. Flashing shall be one piece for lintels and sills.

3.5.4.1 Lintel Flashing

Lintel flashing shall extend the full length of lintel. Flashing shall extend through the wall one masonry course above the lintels and shall be bent down over the vertical leg of the outer steel lintel angle not less than 2 inches, or shall be applied over top of masonry and precast concrete lintels. Bedjoints of lintels at control joints shall be underlaid with sheet metal bond breaker.

3.5.4.2 Sill Flashing

Sill flashing shall extend the full width of the sill and not less than 4 inches beyond ends of sill except at control joint where the flashing shall be terminated at the end of the sill.

3.5.5 Valley Flashing

Valley flashing shall be installed as specified in SMACNA-02 and as indicated.

3.6 GRAVEL STOPS AND FASCIA

Gravel stops and fascia shall be fabricated and installed as indicated and in accordance with SMACNA-02.

3.7 INSTALLATION OF LOUVERS

Louvers shall be rigidly attached to the supporting construction. The installation shall be rain-tight. Louver screen shall be installed as indicated.</TXTalled where sloping roofs surfaced with shingles abut vertical surfaces. Separate pieces of base flashing shall be placed in alternate shingle courses.

3.8 Through-Wall Flashing

Through-wall flashing includes sill, lintel, and spandrel flashing. The flashing shall be laid with a layer of mortar above and below the flashing so that the total thickness of the two layers of the mortar and flashing are the same thickness as the regular mortar joints. Flashing shall not extend further into the masonry backup wall than the first mortar joint. Joints in flashing shall be lapped and sealed. Flashing shall be one piece for lintels and sills.

3.8.1 Lintel Flashing

Lintel flashing shall extend the full length of lintel. Flashing shall extend through the wall one masonry course above the lintels and shall be bent down over the vertical leg of the outer steel lintel angle not less than 2 inches, or shall be applied over top of masonry and precast concrete lintels. Bedjoints of lintels at control joints shall be underlaid with sheet metal bond breaker.

3.8.2 Sill Flashing

Sill flashing shall extend the full width of the sill and not less than 4 inches beyond ends of sill except at control joint where the flashing shall be terminated at the end of the sill.

3.9 Valley Flashing

Valley flashing shall be installed as specified in SMACNA-02 and as indicated.

3.10 GRAVEL STOPS AND FASCIA

Gravel stops and fascia shall be fabricated and installed as indicated and in accordance with SMACNA-02.

3.11 INSTALLATION OF LOUVERS

Louvers shall be rigidly attached to the supporting construction. The installation shall be rain-tight. Louver screen shall be installed as indicated.

3.12 REGLETS

Reglets shall be a factory fabricated product of proven design, complete with fittings and special shapes as required. Open-type reglets shall be filled with fiberboard or other suitable separator to prevent crushing of the slot during installation. Reglet plugs shall be spaced not over 12 inches on centers and reglet grooves shall be filled with sealant. Friction or slot-type reglets shall have metal flashings inserted the full depth of slot and shall be lightly punched every 12 inches to crimp the reglet and counter flashing together. Polyvinyl chloride reglets shall be sealed with the manufacturer's recommended sealant.

3.13 CONTRACTOR QUALITY CONTROL

****

NOTE: When justified by the amount or criticality of the roofing involved, and similar requirements are not specified elsewhere, the following requirement will be added at the end of the paragraph:

A roofing technician responsible directly to the Contractor and experienced in the construction of similar roofing systems and related work shall perform the quality control functions and be on the site when roofing operations are in progress.

****

The Contractor shall establish and maintain a quality control procedure for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the contract requirements. Any work found not to be in compliance with the contract shall be promptly removed and replaced or corrected in an approved manner. Quality control shall include, but not be limited to, the following:

a. Observation of environmental conditions; number and skill level of sheet metal workers; condition of substrate.

b. Verification of compliance of materials before, during, and after installation.

c. Inspection of sheet metalwork for proper size and thickness, fastening and joining, and proper installation.

The actual quality control observations and inspections shall be documented and a copy of the documentation furnished to the Contracting Officer at the end of each day.

-- End of Section --

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SECTION 07720

ROOF VENTILATORS, GRAVITY-TYPE
11/93

****
NOTE: This guide specification covers the requirements for gravity-type roof ventilators including stationary, turbine, and ridge types. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 653/A 653M	(1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	Aluminum and Aluminum-Alloy Sheet and

Plate (Metric)

ASTM B 221 (1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7 (1995) Minimum Design Loads for Buildings & Other Structures

1.2 DESIGN REQUIREMENTS

****

NOTE: To determine the ventilator size and performance requirements, the latest ventilator manufacturer's recommendations should be used, including latest ASHRAE Handbook "Fundamentals" published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers.

****

Ventilators shall be designed for use with the specific type of project roofing system, and shall provide uniform and continuous air flow. Ventilator design shall provide protection against rain and snow, and shall be provided with a continuous weep along the bottom of both sides of wind band. Units shall be self-cleaning by the action of the elements, and shall have provisions for carrying water and normal wind-transported soil matter to the outside. Units shall be designed for windspeeds of not less than [80] [_____] mph in accordance with ASCE 7. Ventilators shall be free of internal obstructions or moving parts which will require maintenance, and shall be complete with type of mounting indicated on drawings.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Roof Ventilators; [_____].

Dimensioned drawings indicating location of each type of ventilator including details of construction, gauges of metal, and methods of operation of dampers and controls.

1.4 QUALIFICATION

Manufacturer shall specialize in design and manufacture of the type of roof ventilators specified in this section, and shall have a minimum of [_____] years of documented successful experience. Ventilator installer shall be experienced in the installation of ventilator types specified.

1.5 DELIVERY, STORAGE AND HANDLING

Roof ventilators shall be cartoned or crated prior to shipment. Ventilators shall be protected from moisture and damage. Damaged items shall be removed from site.

1.6 PROJECT/SITE CONDITIONS

Rough openings shall be field-measured and recorded on shop drawings prior to fabrication of roof ventilators. Fabrication shall be scheduled with construction schedule.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Materials selected for ventilators will be based on the degree of permanence of the installation. Typically, aluminum will be used for permanent-type installation, and galvanized steel will be used for a temporary nature. For special situations where appearance is important, or resistance to specific corrosive conditions is required, special paint type coatings are available from manufacturers. Manufacturers' literature should be reviewed to specify special coatings.

****

2.1.1 Aluminum Extrusions

Aluminum extrusions shall be alloy 6063, temper T5 in compliance with ASTM B 221.

2.1.2 Aluminum Sheets

Aluminum sheets shall be alloy 5005, temper H15 or alloy 3003, temper H14 in compliance with ASTM B 209.

2.1.3 Galvanized Steel Sheets

Steel sheets shall be commercial quality, zinc-coated steel (hot-dip galvanized) of quality established by ASTM A 653/A 653M, minimum G90 coating thickness.

2.2 RIDGE VENTILATORS

Roof ridge ventilators shall be fabricated of [galvanized steel] [aluminum], and shall be assembled to any desired length. Continuous-run ridge ventilators shall be connected with splice plates of type which will telescope together and not require fasteners, soldering or welding. Ventilators shall be provided with [manually-operated single-leaf dampers complete with accessories to meet design and performance requirements.] [UL labeled fire-actuated damper system complete with accessories to meet building code requirements.] Dampers and airshafts shall be complete with urethane gasketing for extra-tight enclosures. Metal closure strips which match the panel roof rib contours shall be provided to close out weather and provide a secure seat for ventilators. [Insect] [Bird] screens shall be provided.

2.3 STATIONARY VENTILATORS

****

NOTE: Review building code requirements to determine if no damper or manually-operated dampers are acceptable. If dampers must meet fire code requirements, carefully review code and ventilator manufacturer's data before editing this spec.

****

Stationary roof ventilators shall be fabricated of [galvanized steel] [aluminum] with seamless spun conical-shaped weathercap, and shall have straight-through drainage for eliminating the possibility of air-borne debris collecting in the ventilator openings. [Insect] [Bird] screens shall be provided.

2.4 TURBINE VENTILATORS

Turbine ventilators shall be fabricated of [galvanized steel] [aluminum] [corrugated] [flat] sheets, complete with sensitive ball-bearing action to enable the slightest motion of air to move the rotor head where suction is maintained at low wind velocities. Ventilators shall have 360 degree operating surface to assure access of wind currents regardless of wind velocities. Rotor head shall be anchored to prevent head from lifting or jumping off the rotor in high winds. Rotor crown plate shall be seamless. [Bird] [Insect] screens shall be provided.

2.4.1 Dampers

Turbine ventilators shall be provided with [dampers manually-operated with direct pull-chain or rack and pinion] [push-button control electric gear motor-operated dampers] [thermostat control electric gear motor-operated dampers].

2.4.2 Rotor Shaft

Rotor shaft bearings shall be entirely shielded in corrosion-resistant aluminum casing. Bearings shall be pre-lubricated and shall have life-time warranty. Bearings shall be at top and bottom to assure accurate alignment. Shaft and bearings shall be easily replaceable as a unit. Rotor collar shall be rolled and welded.

2.5 FABRICATION

Ventilators shall be fabricated in accordance with approved shop drawings.

Welds, soldered seams, rivets and fasteners shall be clean, secure, watertight, and smooth. Edges shall be wired or beaded, where necessary, to ensure rigidity. Joints between sections shall be watertight and shall allow for expansion and contraction. Galvanic action between different metals in direct contact shall be prevented by nonconductive separators.

2.6 CURB BASES

****
NOTE: Delete this paragraph if flange-mounting is used.
****

Ventilator bases for curb-mounted installations shall be of size indicated on drawings, and shall be designed specifically for the type of ventilator and roofing system approved for this project. Curb bases shall be factory-formed and flashed for a watertight installation. Curb bases shall be fabricated of material and finish to match the ventilator.

2.7 SCREENS

****
NOTE: Insect screens are typically required for ventilators in hospitals, mess halls, bakeries and similar buildings. Insect screens should not be used when exhausting noxious gases because insect screens will clog up. Bird screens should be used where insect screens are not required. Edit as required.
****

Screens shall be furnished by ventilator manufacturer as part of ventilator assembly. Screen (with frames) shall be manufactured of material to match ventilators, and shall be designed to be easily removed for cleaning purposes.

2.8 FINISH

2.8.1 Galvanized Steel Finish

Galvanized steel roof ventilators shall be factory-coated with rust-resistant primer and [baked-on finish coats of acrylic] [finish coats to match metal roof panels] [two-coat high-performance coating system] [field-painted in accordance with Section 09900 PAINTING, GENERAL] [_____].

2.8.2 Aluminum Finish

Aluminum roof ventilators shall be factory-finished [to match metal roof finish and color] [with two-coat fluoropolymer high-performance coating system] [_____].

2.8.3 Color

Color shall be in accordance with [Section 09915 COLOR SCHEDULE] [_____].

PART 3 EXECUTION

3.1 PREPARATION

Rough openings and other roof conditions shall be prepared in accordance with approved shop drawings and manufacturer's recommendations. Before starting the ventilator work, surrounding roof surfaces shall be protected from damage.

3.2 INSTALLATION

Roof ventilator installation shall be coordinated with roofing work, and shall be installed in accordance with approved shop drawings and manufacturer's published instructions. The ventilator installation shall be watertight and shall be free of vibration noise. Aluminum surfaces shall be protected from direct contact with incompatible materials. Aluminum surfaces which will be in contact with sealant shall not be coated with a protective material. Aluminum shall not be used with copper or with water which flows over copper surfaces. Roof ventilators shall be cleaned in accordance with ventilator manufacturer's recommendations.

3.3 PROTECTION

Exposed ventilator finish surfaces shall be protected against the accumulation of paint, grime, mastic, disfigurement, discoloration and damage for duration of construction activities.

-- End of Section --

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05/98

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SECTION 07840

FIRESTOPPING
05/98

****
NOTE: This guide specification covers the requirements for firestopping using fire resistant materials to form an effective barrier against the spread of fire, smoke and gases, and to maintain the integrity of fire resistance rated construction. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL: http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84	(1998e1) Surface Burning Characteristics of Building Materials
ASTM E 119	(1998) Fire Tests of Building Construction and Materials
ASTM E 814	(1997) Fire Tests of Through-Penetration Fire Stops

UNDERWRITERS LABORATORIES (UL)

UL 723	(1996) Test for Surface Burning Characteristics of Building Materials
UL 1479	(1994; Rev thru Feb 1998) Fire Tests of Through-Penetration Firestops
UL 2079	(1998) Tests for Fire Resistance of Building Joint Systems
UL Fire Resist Dir	(1998) Fire Resistance Directory (2 Vol.)

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Firestopping Materials; [_____].

Detail drawings including manufacturer's descriptive data, typical details, installation instructions and the fire-test data and/or report as appropriate for the fire resistance rated construction and location. Submittal shall indicate the firestopping material to be provided for each type of application. When more than 5 penetrations or construction joints are to receive firestopping, drawings shall indicate location and type of application.

SD-13 Certificates

Firestopping Materials; [_____].

Certificates attesting that firestopping material complies with the specified requirements. The label or listing of the Underwriters Laboratories will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing agency equipped to perform such services, stating that the items have been tested and conform to the specified requirements and testing methods.

Installer Qualifications; [_____].

Documentation of training and experience.

Inspection; [_____].

Manufacturer's representative certification stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

1.3   GENERAL REQUIREMENTS

Firestopping shall consist of furnishing and installing a material or a combination of materials to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; firestopping material shall not interfere with the required movement of the joint. Gaps requiring firestopping include gaps between the curtain wall and the floor slab and between the top of the fire-rated walls and the roof deck.

1.4   STORAGE AND DELIVERY

Materials shall be delivered in the original unopened packages or containers showing name of the manufacturer and the brand name. Materials shall be stored off the ground and shall be protected from damage and exposure to elements. Damaged or deteriorated materials shall be removed from the site.

1.5   INSTALLER QUALIFICATIONS

Installer of firestopping material shall be trained by the manufacturer or the manufacturer's representative, and shall have a minimum of 3 years experience in the installation of firestopping of the type specified.

PART 2   PRODUCTS

2.1   FIRESTOPPING MATERIALS

Firestopping materials shall consist of commercially manufactured products complying with the following minimum requirements:

2.1.1 Fire Hazard Classification

Material shall have a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with ASTM E 84 or UL 723. Material shall be an approved firestopping material as listed in UL Fire Resist Dir or by a nationally recognized testing laboratory.

2.1.2 Toxicity

Material shall be nontoxic to humans at all stages of application.

2.1.3 Fire Resistance Rating

Firestopping will not be required to have a greater fire resistance rating than that of the assembly in which it is being placed.

2.1.3.1 Through-Penetrations

****

Note: Insert the appropriate time period required. Indicate locations of fire resistance rated walls, partitions, floors, ceiling-floor assemblies and other locations requiring firestopping.

****

Firestopping materials for through-penetrations, as described in paragraph GENERAL REQUIREMENTS, shall provide "F" and "T" fire resistance ratings in accordance with ASTM E 814 or UL 1479, except that T Ratings are not required for penetrations smaller than or equal to a 4 inch nominal pipe or 16 square inches in overall cross sectional area. Fire resistance ratings shall be the following:

a. Penetrations of Fire Resistance Rated Walls and Partitions: F Rating = [_____] hour, T Rating = [_____] hour.

b. Penetrations of Fire Resistance Rated Floors and Ceiling-Floor Assemblies: F Rating = [_____] hour, T Rating = [_____] hour.

2.1.3.2 Construction Joints and Gaps

Fire resistance ratings of construction joints, as described in paragraph GENERAL REQUIREMENTS, and gaps such as those between floor slabs or roof decks and curtain walls shall be [the same as the construction in which they occur.] [as follows: construction joints in walls, [_____] hour; construction joints in floors, [_____] hour; gaps between floor slabs and curtain walls, [_____] hour; gaps between top of the walls and the bottom of roof decks, [_____] hour.] Construction joints and gaps shall be provided with firestopping materials and systems that have been tested per ASTM E 119 or UL 2079 to meet the required fire resistance rating.

PART 3 EXECUTION

3.1 PREPARATION

Areas to receive firestopping shall be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system.

3.2 INSTALLATION

****

NOTE: Drawings must indicate location and fire ratings of all fire-rated walls, partitions, floors and ceilings.

****

Firestopping material shall completely fill void spaces regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping for filling floor voids 4 inches or more in any direction shall be capable of supporting the same load as the floor is designed to support or shall be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Firestopping shall be installed in accordance with manufacturer's written instructions. Firestopping shall be provided in the following locations, except in floor slabs on grade:

a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.

b. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.

c. Gaps at the intersection of floor slabs and curtain walls, including inside of hollow curtain walls at the floor slab.

d. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of roof decks.

e. Construction joints in floors and fire rated walls and partitions.

f. Other locations where required to maintain fire resistance rating of the construction.

3.3 INSPECTION

****

NOTE: Delete inspection by manufacturer's representative for small projects.

****

Firestopped areas shall not be covered or enclosed until inspection is complete and approved. A manufacturer's representative shall inspect the applications initially to ensure adequate preparations (clean surfaces suitable for application, etc.) and periodically during the work to assure that the completed work has been accomplished according to the manufacturer's written instructions and the specified requirements.

-- End of Section --

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06/97

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SECTION 07900

JOINT SEALING
06/97

****

NOTE: This guide specification covers the requirements for sealing of joints in building construction. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

****

NOTE: Guidance on joint design and use of sealants is available in ASTM C 1193 and TM 5-805-6.

Fire rated joints should be filled as specified in section 07270 FIRESTOPPING. Control and expansion joints for fire-rated walls will be designed in accordance with Series J900, U900 or U400 designs in the UL Fire Resistance Directory.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 509	(1994) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C 570	(1995) Oil- and Resin-Base Caulking Compound for Building Construction
ASTM C 734	(1993) Low-Temperature Flexibility of Latex Sealants After Artificial Weathering
ASTM C 834	(1995) Latex Sealants
ASTM C 920	(1995) Elastomeric Joint Sealants
ASTM C 1085	(1991) Butyl Rubber-Based Solvent-Release Sealants
ASTM C 1184	(1995) Structural Silicone-Sealants
ASTM D 217	(1994) Cone Penetration of Lubricating Grease (IP50/88)
ASTM D 1056	(1991) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1565	(1981; R 1990) Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Open-Cell Foam)
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Backing; [_____]. Bond-Breaker; [_____].

Sealant; [_____].

Manufacturer's descriptive data including storage requirements, shelf life, curing time, instructions for mixing and application, and primer data (if required). A copy of the Material Safety Data Sheet shall be provided for each solvent, primer or sealant material.

SD-13 Certificates

Sealant; [_____].

Certificates of compliance stating that the materials conform to the specified requirements.

1.3 ENVIRONMENTAL REQUIREMENTS

The ambient temperature shall be within the limits of 40 to 90 degrees F when the sealants are applied.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the job in the manufacturer's original unopened containers. The container label or accompanying data sheet shall include the following information as applicable: manufacturer, name of material, formula or specification number, lot number, color, date of manufacture, mixing instructions, shelf life, and curing time at the standard conditions for laboratory tests. Materials shall be handled and stored to prevent inclusion of foreign materials. Materials shall be stored at temperatures between 40 and 90 degrees F unless otherwise specified by the manufacturer.

PART 2 PRODUCTS

****

NOTE: Designer may describe each material on the drawings or designate each different material by placing a letter or other identifier in the first set of blank brackets, provided in the following paragraphs, to agree with designations on the drawing notes. Other brackets must be filled with the proper information shown in the referenced ASTM, indicated in the Notes or provided by the manufacturer.

When required, specify or indicate sealant color.

Designer should require materials, products, and innovative construction methods and techniques which

are environmentally sensitive, take advantage of recycling and conserve natural resources.
****

2.1 BACKING

Backing shall be 25 to 33 percent oversize for closed cell and 40 to 50 percent oversize for open cell material, unless otherwise indicated.

2.1.1 Rubber

****
NOTE: Class A is adequate for most applications. Select Class B for petroleum oil or fuel resistance. Select Class D for temperatures of minus 75 to 175 degrees C (minus 103 to 347 degrees F) with no oil exposure.

Specify Type 2 closed cell when moisture may migrate to the backing.
****

[_____] Cellular rubber sponge backing shall be ASTM D 1056, [Type 1, open cell,] [or] [Type 2, closed cell,] Class [A] [B] [D], Grade [_____], [round] [_____] cross section.

2.1.2 PVC

****
NOTE: Do not use open cell vinyl foam in moist areas or below grade.
****

[_____] Polyvinyl chloride (PVC) backing shall be ASTM D 1565, Grade [VO 12] [_____], open-cell foam, [round] [_____] cross section.

2.1.3 Synthetic Rubber

****
NOTE: Use Option I and Type I for most applications. Select Option II only if flame resistance is NOT required. Type II provides the highest ozone resistance.
****

[_____] Synthetic rubber backing shall be ASTM C 509, Option [I] [II], Type [I] [II] preformed [rods] [or] [tubes].

2.1.4 Neoprene

[_____] Neoprene backing shall be ASTM D 1056, [closed cell expanded neoprene cord Type 2, Class C, Grade [2C2] [_____]] [open cell neoprene sponge Type 1, Class C, Grade [1C3] [_____]].

2.2 BOND-BREAKER

Bond-breaker shall be as recommended by the sealant manufacturer to prevent adhesion of the sealant to backing or to bottom of the joint.

2.3 PRIMER

Primer shall be non-staining type as recommended by sealant manufacturer for the application.

2.4 CAULKING

****

NOTE: The term "caulking" is limited herein to oil- and resin-based caulking which should be used only indoors and where there is little or no anticipated joint movement. Use a sealant where joints may move.

****

[_____] Oil- and resin-based caulking shall be ASTM C 570, Type [_____], Use [_____].

2.5 SEALANT

2.5.1 LATEX

[_____] Latex Sealant shall be ASTM C 834.

2.5.2 ELASTOMERIC

****

NOTE: Select elastomeric sealant type, grade, use, and class from these options:

Types: S, Single-; M, Multi-component.
Grades: P, Pourable; NS, Non-Sag.
Classes: Withstand 25 or 12.5 percent joint movement.

USES: NT, No Traffic; T, Traffic; M, Mortar; G, Glass; A, Aluminum; and O, Other.

Use structural silicone sealant for supporting weight of glass or thin stone.

****

Elastomeric sealants shall conform to ASTM C 920 and the following:

a. [_____] Polysulfide Sealant: Type [S] [M], Grade [NS] [P], Class [25] [12.5], Use NT, [M] [G] [A] [O].

b. [_____] Polyurethane sealant: Grade [NS] [P], Class [25] [12.5], Use [T] [NT] [M] [G] [A] [O].

c. [_____] Silicone sealant: Type [S] [M], Grade [NS] [P], Class [25] [12.5], Use NT, [M] [G] [A] [O].

d. [_____] Structural silicone sealant: ASTM C 1184, Type [S] [M], Use [G] [O].

2.5.3 ACOUSTICAL

****
NOTE: See ASTM C 919 for use of acoustical sealant. The acoustical sealant described here is to be used only in non-moving joints protected from abuse. Other specified sealants may be used in acoustical applications when appropriate.
****

[_____] Rubber or polymer-based acoustical sealant shall have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E 84. Acoustical sealant shall have a consistency of 250 to 310 when tested in accordance with ASTM D 217, and shall remain flexible and adhesive after 500 hours of accelerated weathering as specified in ASTM C 734, and shall be non-staining.

2.5.4 BUTYL

[_____] Butyl sealant shall be ASTM C 1085.

2.5.5 PREFORMED

Preformed sealant shall be polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealant capable of sealing out moisture, air and dust when installed as recommended by the manufacturer. At temperatures from minus 30 to plus 160 degrees F, the sealant shall be non-bleeding and shall have no loss of adhesion.

2.5.5.1 Tape

[_____] Tape sealant: cross-section dimensions shall be [_____].

2.5.5.2 Bead

[_____] Bead sealant: cross-section dimensions shall be [_____].

2.5.5.3 Foam Strip

****
NOTE: Untreated polyurethane foam can be used where exposed to view or where staining of adjacent surfaces is not acceptable.
****

[_____] Foam strip shall be polyurethane foam; cross-section dimensions shall be [_____]. Foam strip shall be capable of sealing out moisture, air, and dust when installed and compressed as recommended by the manufacturer. Service temperature shall be minus 40 to plus 275 degrees F. Untreated strips shall be furnished with adhesive to hold them in place. Adhesive shall not stain or bleed into adjacent finishes. Treated strips shall be saturated with butylene waterproofing or impregnated with asphalt.

2.6 SOLVENTS AND CLEANING AGENTS

Solvents, cleaning agents, and accessory materials shall be provided as recommended by the manufacturer.

PART 3 EXECUTION

3.1 GENERAL

****

NOTE: Identify sealants which should not be painted in Section 09900 PAINTING, GENERAL. Avoid painting elastomeric sealants in joints which move. Most silicones will not accept paint.

****

3.1.1 Surface Preparation

The surfaces of joints to receive sealant or caulk shall be free of all frost, condensation and moisture. Oil, grease, dirt, chalk, particles of mortar, dust, loose rust, loose mill scale, and other foreign substances shall be removed from surfaces of joints to be in contact with the sealant. Oil and grease shall be removed with solvent and surfaces shall be wiped dry with clean cloths. For surface types not listed below, the sealant manufacturer shall be contacted for specific recommendations.

3.1.2 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, the materials shall be removed by sandblasting or wire brushing. Laitance, efflorescence and loose mortar shall be removed from the joint cavity.

3.1.3 Steel Surfaces

Steel surfaces to be in contact with sealant shall be sandblasted or, if sandblasting would not be practical or would damage adjacent finish work, the metal shall be scraped and wire brushed to remove loose mill scale. Protective coatings on steel surfaces shall be removed by sandblasting or by a solvent that leaves no residue.

3.1.4 Aluminum Surfaces

Aluminum surfaces to be in contact with sealants shall be cleaned of temporary protective coatings. When masking tape is used for a protective cover, the tape and any residual adhesive shall be removed just prior to applying the sealant. Solvents used to remove protective coating shall be as recommended by the manufacturer of the aluminum work and shall be non-staining.

3.1.5 Wood Surfaces

Wood surfaces to be in contact with sealants shall be free of splinters and sawdust or other loose particles.

3.2 APPLICATION

3.2.1 Masking Tape

Masking tape [shall] [may] be placed on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Masking tape shall be removed within 10 minutes after joint has been filled and tooled.

3.2.2 Backing

Backing shall be installed to provide the indicated sealant depth. The installation tool shall be shaped to avoid puncturing the backing.

3.2.3 Bond-Breaker

Bond-breaker shall be applied to fully cover the bottom of the joint without contaminating the sides where sealant adhesion is required.

3.2.4 Primer

Primer shall be used on concrete masonry units, wood, or other porous surfaces in accordance with instructions furnished with the sealant. Primer shall be applied to the joint surfaces to be sealed. Surfaces adjacent to joints shall not be primed.

3.2.5 Sealant

Sealant shall be used before expiration of shelf life. Multi-component sealants shall be mixed according to manufacturer's printed instructions. Sealant in guns shall be applied with a nozzle of proper size to fit the width of joint. Joints shall be sealed as detailed in the drawings. Sealant shall be forced into joints with sufficient pressure to expel air and fill the groove solidly. Sealant shall be installed to the indicated depth without displacing the backing. Unless otherwise indicated, specified, or recommended by the manufacturer, the installed sealant shall be dry tooled to produce a uniformly smooth surface free of wrinkles and to ensure full adhesion to the sides of the joint; the use of solvents, soapy water, etc., will not be allowed. Sealants shall be installed free of air pockets, foreign embedded matter, ridges and sags. Sealer shall be applied over the sealant when and as specified by the sealant manufacturer.

3.3 CLEANING

The surfaces adjoining the sealed joints shall be cleaned of smears and other soiling resulting from the sealant application as work progresses.

-- End of Section --

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DEPARTMENT OF THE ARMY — **CEGS-08110 (February 1995)**
U.S. ARMY CORPS OF ENGINEERS — **--------------------------**
Superseding
CEGS-08110 (February 1989)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 3 (September 1999)
Includes Special Change (Tailoring Options) (July 1998)
Includes Text Adjustment Change (Section Reference) (June 1997)

Latest change indicted by CHG tags

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02/95

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Latest change indicted by CHG tags

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SECTION 08110

STEEL DOORS AND FRAMES
02/95

****
NOTE: This guide specification covers the requirements for steel doors, sidelights, transoms and frames. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for fire rated doors, thermal insulated doors, security doors, sound rated doors, weatherstripping, transom and sidelight panels, and louvers. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A250.8	(1998) Steel Doors and Frames

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 236	(1989; R 1993) Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box
ASTM C 976	(1990; R 1996) Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box
ASTM D 2863	(1997) Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM E 90	(1997) Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions
ASTM E 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

DOOR AND HARDWARE INSTITUTE (DHI)

DHI A115.1G	(1994) Installation Guide for Doors and Hardware

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM HMMA 862	(1987) Hollow Metal Manual; Section: Guide Specifications for Commercial Security Hollow Metal Doors and Frames
NAAMM HMMA 865	(1995) Hollow Metal Manual; Section: Guide Specifications for Swinging Sound Control Hollow Metal Doors and Frames

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1999) Fire Doors and FireWindows
NFPA 80A	(1996) Protection of Buildings from

	Exterior Fire Exposures
NFPA 101	(1997; Errata 97-1; TIA-97.1) Life Safety Code
NFPA 252	(1995) Fire Tests of Door Assemblies

STEEL DOOR INSTITUTE (SDOI)

SDOI SDI-106	(1996) Standard Door Type Nomenclature
SDOI SDI-107	(1997) Hardware on Steel Doors (Reinforcement - Application)

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Steel Doors and Frames; [_____].

Drawings using standard door type nomenclature in accordance with SDOI SDI-106 indicating the location of each door and frame, elevation of each model of door and frame, details of construction, method of assembling sections, location and extent of hardware reinforcement, hardware locations, type and location of anchors for frames, and thicknesses of metal. Drawings shall include catalog cuts or descriptive data for the doors, frames, and weatherstripping including air infiltration data and manufacturers printed instructions.

SD-09 Reports

Fire Rated Doors; [_____].

A letter by a nationally recognized testing laboratory which identifies the product manufacturer, type, and model; certifying that the laboratory has tested a sample assembly in accordance with NFPA 252 and issued a current listing for same.

SD-13 Certificates

Fire Rated Doors; [_____]. Thermal Insulated Doors; [_____]. Security Doors; [_____]. Sound Rated Doors; [_____].

a. Certification of Oversized Fire Doors: Certificates of compliance in accordance with the requirements of NFPA 252 for fire doors exceeding the sizes for which label service is available.

b. Certification of [Security Door] [Sound] [Thermal Insulating] Rating: Certification or test report for [security rating] [sound rated] [thermal insulated] doors shall show compliance with the specified requirements. The certification, or test report, shall list the parameters and the type of hardware and perimeter seals used to achieve the rating.

SD-14 Samples

Steel Doors and Frames; [_____].

Manufacturer's standard color samples of factory applied finishes.

1.3 DELIVERY AND STORAGE

During shipment, welded unit type frames shall be strapped together in pairs with heads at opposite ends or shall be provided with temporary steel spreaders at the bottom of each frame; and knockdown type frames shall be securely strapped in bundles. Materials shall be delivered to the site in undamaged condition, and stored out of contact with the ground and under a weathertight covering permitting air circulation. Doors and assembled frames shall be stored in an upright position in accordance with DHI A115.1G. Abraded, scarred, or rusty areas shall be cleaned and touched up with matching finishes.

1.4 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2 PRODUCTS

****

NOTE:

1. The drawings will show the grade, model, thickness, and size of door to be used. ANSI A250.8 will be used to determine the grade and model. ANSI A250.8 specifies both full flush and flush panel doors; both models will be generally retained as Contractor's option. Where appearance is a major consideration, one model of door may be exclusively specified in this paragraph.

2. Doors and frames are classified as standard (Grade I), heavy (Grade II) and extra heavy duty (Grade III) based on anticipated frequencies of use of 250,000; 500,000; and 1,000,000 cycles respectively and exposure to physical abuse.

Standard duty doors are intended for low frequency

applications not subject to physical abuse. Heavy duty doors should be used in most situations when doors are subjected to frequent use and moderate physical abuse. Extra heavy duty doors should be used as main entrance doors to buildings, and in industrial applications where doors may be subjected to physical abuse, and may be used in lieu of heavy duty doors when a heavier door is needed to meet local conditions.

Dimension of reinforcing members, other than thickness, are manufacturer's standard. Reinforcing plate dimensions should be specified if deemed necessary for a unique situation. Full glazed stile-and-rail doors are intended for use as entrance doors in buildings of general public access only, such as libraries, headquarters, and administrative buildings.

3. Standard terminated stops are required on interior frames for hospital construction except at sound-rated doors. Frames requiring terminated stops will be indicated on the drawings and the following added to paragraph 5:

"Standard terminated stops 150 mm (6 inches) from the floor shall be provided on frames identified on the drawings."

4. Galvanized doors will be specified for exterior doors in geographic areas subject to high humidity, salt spray, or corrosive fumes and for interior doors subject to continual wetting or high humidity.

5. Interior steel doors between an air conditioned/heated space and a non-conditioned space will be thermal insulated.

6. Where warranted, door frames of a gauge thicker than the Grades I, II, or III may be selected for very large doors or where frames will be subject to frequent and heavy physical abuse.

****

2.1 DOORS AND FRAMES

****

NOTE: Some areas do not need galvanized protection. Interior doors without moisture conditions normally do not require galvanized protection. Interior doors and protected exterior doors with moderate moisture conditions may require the A40 galvanized protection. G60 galvanized coating may be selected for steel exterior and interior doors subject to high moisture. The G60 galvanized coating with

baked on primer coat and field or factory painted finish will be used for coastal areas. Determine need for galvanizing and edit accordingly.
****

Doors and frames shall be factory fabricated in accordance with ANSI A250.8 and the additional requirements specified herein. Door grade shall be [standard (Grade I)] [heavy duty (Grade II)] [extra heavy duty (Grade III)] unless otherwise indicated on the door and door frame schedules. [Exterior doors and frames shall be designation [A40] [G60] galvanized.] [Indicated interior doors and frames shall be designation [A40] [G60] galvanized.] Doors and frames shall be prepared to receive hardware conforming to the templates and information provided under Section 08700 BUILDERS' HARDWARE. Doors and frames shall be reinforced, drilled, and tapped to receive mortised hinges, locks, latches, and flush bolts as required. Doors and frames shall be reinforced for surface applied hardware. Frames shall be [knockdown type] [and] [welded type] located [as shown] [_____]. Door frames shall be furnished with a minimum of three jamb anchors and one floor anchor per jamb. Anchors shall be not less than 18 gauge steel or 7 gauge diameter wire. For wall conditions that do not allow the use of a floor anchor, an additional jamb anchor shall be provided. Rubber silencers shall be furnished for installation into factory predrilled holes in door frames; adhesively applied silencers are not acceptable. Where frames are installed in plaster or masonry walls, plaster guards shall be provided on door frames at hinges and strikes. Full glass doors shall conform to ANSI A250.8, Model 3, and shall include provisions for glazing. Reinforcing of door assemblies for closers and other required hardware shall be in accordance with ANSI A250.8and the conditions of the fire door assembly listing when applicable. Exterior doors shall have top edges closed flush and sealed against water penetration.

2.2 FIRE RATED DOORS

****
NOTE: Door schedule on drawings will indicate where fire-rated doors are to be used and their rating requirements. Edit paragraph to meet project requirements.
****

Fire rated door assemblies shall bear the listing identification label of a nationally recognized testing laboratory qualified to perform tests of fire door assemblies in accordance with NFPA 252 and having a listing for the tested assemblies. The fire resistance rating shall be [[3 hr. (A)] [1-1/2 hr ([B][D])] [3/4 hr ([C][E])] [1/2 hr] [1/3 hr] rated] [as shown]. Doors exceeding the sizes for which listing label service is offered shall be in accordance with NFPA 252. Listing identification labels shall be constructed and permanently applied by a method which results in their destruction should they be removed.

2.3 THERMAL INSULATED DOORS

The interior of thermal insulated doors shall be completely filled with rigid plastic foam permanently bonded to each face panel. The thermal conductance (U-value) through the door shall not exceed [0.41 btu/hr times sq f times f] [_____] when tested as an operational assembly in accordance with ASTM C 236 or ASTM C 976. Doors with cellular plastic cores shall have a minimum oxygen index rating of 22 percent when tested in accordance with ASTM D 2863.

2.4 SECURITY DOORS

****

NOTE: Security doors are typically used for protection against super power small arms (SPSA) and forced entry into buildings, such as retail stores, warehouses, factories, tool rooms and offices, especially on alley side, rear, or dark side of buildings. Refer to AR 190-51 and Section 13958, FORCED ENTRY RESISTANT COMPONENTS.

****

Security type doors and frames shall be factory fabricated in accordance with NAAMM HMMA 862 and the additional requirements specified herein. Doors and frames shall be galvanized [14] [12] gauge construction. Doors shall have [14] [12] gauge steel plate on both sides, and be internally reinforced vertically with continuous 20 gauge steel stiffeners spaced 6 inches on center maximum. Doors shall be fully welded seamless construction with no visible seams or joints on their faces or vertical edges. Door thickness shall be 1-3/4 inches. Exterior doors shall be insulated to provide a thermal conductance (U-value) not to exceed [0.41 btu/hr times sq f times f] [_____] when tested as an operational assembly in accordance with ASTM C 236 or ASTM C 976. Doors with cellular plastic cores shall have a minimum oxygen index rating of 22 percent when tested in accordance with ASTM D 2863. Door frames shall be all welded type, with [double rabbet] [single rabbet] [splayed] jamb profile. At meeting stiles, an astragal shall be provided by extending the face panel of the active leaf not less than 5/8 inch across the gap between the two leaves. Astragal shall be flush with the face panel of the inactive leaf. Frame corners shall be machine-mitered, full (continuously) welded. All exposed welds shall be ground and finished smooth.

2.5 SOUND RATED DOORS

Sound rated doors and frames shall be factory fabricated in accordance with NAAMM HMMA 865 and shall be provided at locations shown on the drawings. Door assemblies shall consist of 18 gauge minimum thickness door, 14 gauge minimum thickness frame, and adjustable perimeter seals. The Sound Transmission Class rating of the assembly shall be [45] [_____] [as shown on the drawings] when tested in accordance with ASTM E 90.

2.6 WEATHERSTRIPPING

****

NOTE: Exterior steel doors will be provided with thresholds and weatherstripping. Thresholds and weatherstripping specified in Section 08700 BUILDERS' HARDWARE and this paragraph will be coordinated to avoid conflicts.

****

Unless otherwise specified in Section 08700 BUILDERS' HARDWARE, weatherstripping shall be as follows: Weatherstripping for head and jamb shall be manufacturer's standard elastomeric type of synthetic rubber, vinyl, or neoprene and shall be installed at the factory or on the jobsite in accordance with the door frame manufacturer's recommendations.

Weatherstripping for bottom of doors shall be as shown. Air leakage rate of weatherstripping shall not exceed 0.20 cfm per linear foot of crack when tested in accordance with ASTM E 283 at standard test conditions.

2.7 TRANSOM AND SIDELIGHT PANELS

****

NOTE: When steel panels to match the appearance of the doors are required for transoms or sidelights, the following will be used. Edit paragraph as required.

****

Panels for [transom] [and] [sidelight] shall be constructed in accordance with ANSI A250.8. Panels shall be nonremovable from the outside of exterior doors or the unsecure side of interior doors.

2.8 LOUVERS

****

NOTE: A variety of louvers and grilles are available. The choice of louvers must be determined by the designer in accordance with aesthetics, function, and economics. Listed louvers for fire doors are available and may be provided when acceptable to the labeling agency and the authority having jurisdiction. Omit the sentence about insect screens if not needed. Edit the paragraph as required.

****

Where indicated, doors shall be provided with [full louvers] [or] [louver sections]. Louvers shall be sightproof type [pierced into the panels of the door] [inserted into the door]. Pierced louvers shall not be used on exterior doors. Inserted louvers shall be [stationary] [adjustable]. Louvers shall be nonremovable from the outside of exterior doors or the unsecure side of interior doors. Insect screens shall be a removable type with 18 by 16 mesh aluminum or bronze cloth. Full louver doors shall be in accordance with ANSI A250.8, Grade III, Model 3.

2.9 GLAZING

Glazing shall be as specified in Section [08810 GLASS AND GLAZING] [08840 PLASTIC GLAZING]. Removable glazing beads shall be screw-on or snap-on type.

2.10 FACTORY FINISH

[Doors] [and] [frames] shall be phosphatized [, primed, and finished with an electrostatic baked on enamel or polyester base factory finish paint] [and primed with standard factory primer] system. Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: Solid grouting will be required for all hollow metal door frames in masonry walls, solid plaster, or steel stud walls except when drywall is used. Edit text as required.
****

Installation shall be in accordance with DHI A115.1G. Preparation for surface applied hardware shall be in accordance with SDOI SDI-107. Rubber silencers shall be installed in door frames after finish painting has been completed; adhesively applied silencers are not acceptable. Weatherstripping shall be installed at exterior door openings to provide a weathertight installation. Installation and operational characteristics of fire doors shall be in accordance with NFPA 80, NFPA 80A and NFPA 101. Hollow metal door frames shall be solid grouted [in [masonry walls] [solid plaster walls] [steel stud walls]] [as shown].

3.1.1 Thermal Insulated Doors

Hardware and perimeter seals shall be adjusted for proper operation. Doors shall be sealed weathertight after installation of hardware and shall be in accordance with Section 07900 JOINT SEALING.

3.1.2 Security Doors

Door frames shall be rigidly anchored in place and provided with antispread space filler reinforcements to prevent disengagement of the lock bolt by prying or jacking of the frame. Jambs shall be filled solid with concrete grout.

3.1.3 Sound Rated Doors

Sound rated doors shall be installed in accordance with the manufacturer's printed instructions. Hardware and perimeter seals shall be adjusted for proper operation.

3.2 FIELD PAINTED FINISH

Steel doors and frames shall be field painted in accordance with Section 09900 PAINTING, GENERAL. Weatherstrips shall be protected from paint. Finish shall be free of scratches or other blemishes. Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

3.3 SPECIAL INSPECTION REQUIREMENTS

****
NOTE: Special Inspection will be specified for the fabrication and erection of structural steel when required in Chapter 3 of FEMA 302, NEHRP RECOMMENDED PROVISIONS FOR SEISMIC REGULATIONS FOR NEW BUILDINGS AND OTHER STRUCTURES; if not required, this paragraph will be deleted.

The designer must indicate, in the contract drawings, all locations where special inspection of welded or bolted connections is required in Chapter 3 of FEMA 302; the indication must include whether continuous or periodic inspection is required.
****

Continuous and/or periodic Special Inspection shall be performed for the connection types and connections indicated on the drawings.

-- End of Section --

****

DEPARTMENT OF THE ARMY **CEGS-08120 (July 1998)**
U.S. ARMY CORPS OF ENGINEERS **-----------------------**
Superseding
CEGS-08120 (March 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

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07/98

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DEPARTMENT OF THE ARMY | **CEGS-08120 (July 1998)**
U.S. ARMY CORPS OF ENGINEERS | **-----------------------**
Superseding
CEGS-08120 (March 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 08120

ALUMINUM DOORS AND FRAMES
07/98

****

NOTE: This guide specification covers the requirements for swing type aluminum doors and frames, adjacent sidelights, transoms, and adjoining glazed systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for full-glazed doors and flush doors. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****

NOTE: Buildings not excluded by AEI Design Criteria will be accessible in accordance with Code of Federal Regulations 36 CFR, Part 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities.

Aluminum doors and frames are intended for use principally as main entrance and vestibule doors,

and for prominent interior doors from lobbies and similar spaces in buildings of public access, where appearance is a major factor.

The following information should be indicated on the project drawings:

a. Size of door openings. Thickness and swing of doors.

b. Elevation of each door and frame type, showing design of door and width of stiles and rails.

c. Details of heads, jambs, sills, mullions, and transom sections. Type and spacing of anchors should be shown.

d. Location of doors required to be handicapped accessible.

e. Type and thickness of glazing required.

Delete requirement for submittal SD-09 when doors are not required for the project.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF-45	(1980; R 1993) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 605	(1998) Voluntary Specification for High Performance Organic Coatings on Architectural Aluminum Extrusions and Panels
AAMA 1503.1	(1988) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	(1995) Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B 221M	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM E 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E 330	(1990) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
ASTM E 331	(1996) Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

1.2 SYSTEM DESCRIPTION

****

NOTE: Doors must be safety glazed. Fixed glazed panels in areas subject to human impact (hazardous locations) also must have safety glazing. "Horizontal protective bars" will not be used as a substitute for safety glazing. Safety glazed panels must have a decal or other permanently applied visual reminder that the opening is glazed.

****

Frames and swing-type aluminum doors, of size and design shown on the drawings, shall be provided at the locations indicated. Frames shall be furnished complete with [doors,] [subframes,] [transoms,] [adjoining sidelights,] [adjoining window wall system,] trim, and other accessories indicated and specified.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Wind Load Performance

****

NOTE: Coordinate with local codes to help determine wind load requirements for projects located in coastal areas subject to hurricane activity.

****

Doors and frames shall be of sufficient strength to withstand a design wind load of [30] [_____] pounds per square foot of supported area with a deflection of not more than 1/175 times the length of the member. Doors shall be tested in accordance with ASTM E 330 at a pressure not less than 1.5 times the design load.

1.3.2 Water Penetration Performance

Frames and fixed areas, and non-handicap complying doors shall have no water penetration when tested in accordance with ASTM E 331 at a pressure of [8][_____] psf.

1.4 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Aluminum Doors and Frames; [_____].

Manufacturer's descriptive data and catalog cuts including air-infiltration data.

SD-04 Drawings

Aluminum Doors and Frames; [_____].

A schedule showing the location of each door and window wall system shall be included with the drawings. Drawings showing elevations of each door and frame type, details and method of anchorage, details of construction, location and installation of hardware, shape and thickness of materials, and details of joints and connections.

SD-06 Instructions

Installation; [_____]. Cleaning; [_____].

Manufacturer's installation instructions and cleaning instructions.

SD-09 Reports

Aluminum Doors; [_____].

For full-glazed and flush doors, certified test reports from an independent testing laboratory, stating that doors are identical in design, materials, and construction to a door that has been tested and meets all test and specified requirements.

SD-14 Samples

Finishes; [_____].

Samples of the [color anodized coating, showing the extreme color range] [painted finish].

1.5 DELIVERY AND STORAGE

Materials delivered to the jobsite shall be inspected for damage, and shall be unloaded with a minimum of handling. Storage shall be in a dry location with adequate ventilation, free from dust, water, and other contaminants, and which permits easy access for inspecting and handling. Materials shall be neatly stored on the floor, properly stacked on nonabsorptive strips or wood platforms. Doors and frames shall not be covered with tarps, polyethylene film, or similar coverings.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one-year period shall be provided.

PART 2 PRODUCTS

2.1 ALUMINUM DOORS AND FRAMES

Extrusions shall comply with ASTM B 221, Alloy 6063-T5 or -T6, except alloy used for anodized color coatings shall be required to produce the specified color. Aluminum sheets and strips shall comply with ASTM B 209, alloy and temper best suited for the purpose. Fasteners shall be hard aluminum or stainless steel.

2.1.1 Finishes

****

NOTE: Specify Class II 0.01 to 0.018 mm (0.4 to 0.7 mil) finish designation AA-M10C22A31 clear (natural) anodized finish or AA-M10C22A32 integral color or AA-M10C22A34 electrolytically deposited color anodized finish when doors will not be subject to excessive wear or abrasion, and will be regularly cleaned and maintained.

Specify Class I 0.018 mm (0.7 mil) finish designation AA-M10C22A41 clear (natural) anodized finish or AA-M10C22A42 or AA-M10C22A44 color anodized finish when doors will be subject to excessive wear, and will not be regularly cleaned and maintained. Also specify these designations when doors will be used in highly corrosive industrial atmospheres where dust, gases, salts, and other destructive elements are in existence that attack metal.

Painted surfaces are ideal for curtain walls and areas where high traffic is not a threat to painted finishes. Painted finishes are available in several colors from most manufacturers. The most common are baked acrylics and silicone-polymers with a 15 to 20 year life and fluoropolymers with a 20 year plus life span. Cost of these finishes are generally related to the life span. Edit paragraph as required.

Finish shall be [clear anodized] [color anodized] [painted] [_____]. [Clear anodized finish shall be [AA-M10C22A31] [AA-M10C22A41].] [Color anodized finish shall be [AA-M10C22A32] [AA-M10C22A34] [AA-M10C22A42] [AA-M10C22A44] in accordance with the requirements of AA DAF-45.] [Painted finish shall be manufacturers standard [fluoropolymer] [_____] in accordance with the requirements of AAMA 605.]

2.1.2   Welding and Fastening

Where possible, welds shall be located on unexposed surfaces. Welds required on exposed surfaces shall be smoothly dressed. Welding shall produce a uniform texture and color in the finished work, free of flux and spatter. Exposed screws or bolts will be permitted only at inconspicuous locations and shall have heads countersunk.

2.1.3   Anchors

Anchors shall be stainless steel or steel with a hot-dipped galvanized finish. Anchors of the sizes and shapes required shall be provided for securing aluminum frames to adjacent construction. Anchors shall be placed [as indicated] [near top and bottom of each jamb and at intermediate points not more than 25 inches apart]. Transom bars shall be anchored at ends, and mullions shall be anchored at head and sill. [Where indicated on the drawings, vertical mullion reinforcement shall be of sufficient length to extend up to the overhead structural slab or framing and be securely attached thereto.] [The bottom of each frame shall be anchored to the rough floor construction with 3/32 inch thick stainless steel angle clips secured to the back of each jamb and to floor construction. Stainless steel bolts and expansion rivets shall be used for fastening clip anchors.] [Door frames free of window wall system shall be reinforced and securely anchored to floor construction.]

2.1.4   Hardware

****

NOTE: Where items of hardware such as the operating mechanism for balanced doors, integral push bars, concealed closing devices, and special panic bolts for exceptionally narrow stile doors are designed as an integral part of the door or frame construction, it may be necessary to revise the specification so these items are furnished as part of the door and frame unit. When door accessories such as finger guards, electric strikes, automatic power operators, and special thresholds, are required, they should be added as necessary to this paragraph.

This guide specification requires that hardware for aluminum doors be specified in the respective section of the project specification. When hardware is specified with the doors, change the guide specification accordingly.
****

Hardware for aluminum doors is specified in Section 08700 BUILDERS' HARDWARE. Doors and frames shall be cut, reinforced, drilled, and tapped at the factory to receive template hardware. Reinforcement shall be provided in the core of doors as required to receive locks, door closers, and other hardware. Doors to receive surface applied hardware shall be reinforced as required.

2.1.5 Glazing

****
NOTE: This guide specification requires that glazing for aluminum doors be specified in the respective section of the project specification. When glazing is specified with the doors, change this paragraph accordingly.

Insulating glass may be used in accordance with AEI Design Criteria.

Multiple glazed insulating glass in aluminum doors and frames with a specified Condensation Resistance Factor (CRF) may be specified for regularly occupied buildings such as barracks, medical facilities, administration buildings, etc. Placement of the doors and frames in a vestibule arrangement might achieve a more meaningful result than requiring a CRF. The CRF is a rating number, obtained under standard test conditions, which predicts the point at which condensation will occur on either the glass or frame of the door or framed unit. Only where outside temperature and inside humidity indicate that condensation may be a problem, should the appropriate CRF be inserted in the space provided. Determination and use of the CRF is described in AAMA 1502.7. The appropriate Condensation Resistance Factor should be selected from the following Table:

MINIMUM RECOMMENDED CONDENSATION RESISTANCE FACTOR (CRF)

OUTSIDE DESIGN C. TEMPERATURE	INDOOR RELATIVE HUMIDITY 10%	15%	20%	25%	30%	35%	40%	45%	50%
- 34 deg. C	43	51	57	62	67	71	74	78	80
- 32 deg. C	40	49	55	60	65	69	73	77	79

- 29 deg. C	37	46	53	58	63	68	71	75	78
- 26 deg. C	33	42	50	56	61	66	70	74	77
- 23 deg. C	29	39	46	53	58	63	68	72	75
- 21 deg. C	24	35	43	49	55	61	65	70	73
- 18 deg. C	18	30	39	46	52	58	63	68	71
- 15 deg. C	12	24	34	41	48	55	60	65	69
- 12 deg. C	4	18	28	36	44	51	57	62	67
- 9 deg. C		10	21	30	38	46	52	59	63
- 7 deg. C			13	23	32	40	48	55	60
- 4 deg. C			3	14	24	33	41	49	55
- 1 deg. C				3	14	25	34	43	49

1: Window manufacturer must be consulted to determine availability of units with CRF higher than 62.

2: The table is based on 20 deg. C inside temperature and an outside wind velocity of 24 km per hour.

MINIMUM RECOMMENDED CONDENSATION RESISTANCE FACTOR (CRF)

OUTSIDE DESIGN F. TEMPERATURE	INDOOR RELATIVE HUMIDITY 10%	15%	20%	25%	30%	35%	40%	45%	50%
- 30 deg. F	43	51	57	62	67	71	74	78	80
- 25 deg. F	40	49	55	60	65	69	73	77	79
- 20 deg. F	37	46	53	58	63	68	71	75	78
- 15 deg. F	33	42	50	56	61	66	70	74	77
- 10 deg. F	29	39	46	53	58	63	68	72	75
- 5 deg. F	24	35	43	49	55	61	65	70	73
0 deg. F	18	30	39	46	52	58	63	68	71
+ 5 deg. F	12	24	34	41	48	55	60	65	69
+ 10 deg. F	4	18	28	36	44	51	57	62	67
+ 15 deg. F		10	21	30	38	46	52	59	63
+ 20 deg. F			13	23	32	40	48	55	60
+ 25 deg. F			3	14	24	33	41	49	55
+ 30 deg. F				3	14	25	34	43	49

1: Window manufacturer must be consulted to determine availability of units with CRF higher than 62.

2: The table is based on 68 deg. F inside temperature and an outside wind velocity of 15 miles per hour.
****

Glazing shall be as specified in Section 08810 GLASS AND GLAZING. Metal glazing beads, vinyl inserts, and glazing gaskets shall be provided for securing glass. Glass stops shall be tamperproof on exterior side.

2.1.6 Weatherstripping

Weatherstripping shall be continuous silicone-treated wool pile type, or a type recommended by the door manufacturer and shall be provided on head and jamb of exterior door frames. Weatherstripping for bottom of doors shall be as shown. Weatherstripping shall be easily replaced without special tools, and shall be adjustable at meeting stiles of pairs of doors. Air leakage rate of weatherstripping shall not exceed 0.5 cubic feet per minute per lineal foot of crack when tested in accordance with ASTM E 283 at standard test conditions.

2.2 ALUMINUM FRAMES

Frames shall be [[non-glazed for doors only] [single-glazed window wall system] [double-glazed window wall system and shall have a minimum total average unit thermal resistance of R value 1.92]] [double-glazed window wall system and shall have a minimum condensation resistance factor of [_____] in accordance with AAMA 1503.1]. Frames shall be fabricated of extruded aluminum shapes to contours as shown on the drawings. Shapes shown are representations of design, function, and required profile. Dimensions shown are minimum. Shapes of equivalent design may be submitted, subject to approval of samples. Minimum metal wall thickness shall be 0.090 inch, except glazing beads, moldings, and trim shall be not less than 0.050 inch. Frames that are to receive glass shall have removable snap-on glass stops and glazing beads. Joints in frame members shall be milled to a hairline tight fit so that raw edges of the assembly are not visible, sealed internally to prevent water infiltration, reinforced, and secured mechanically by appropriate screws or by screw spline attachment.

2.3 ALUMINUM DOORS

Doors shall be not less than 1-3/4 inches thick. Clearances at hinge stiles, lock stiles and top rails, floors and thresholds, shall comply with manufacturer's standard. Single-acting doors shall be beveled 1/8 inch at lock and meeting stile edges. Double-acting doors shall have rounded edges at hinge stile, lock stile, and meeting stile edges.

2.3.1 Full-Glazed Stile and Rail Doors

****

NOTE: On full-glazed aluminum doors that will be accessible to the handicapped, the bottom rail will be a minimum of 250 mm (10 inches) high, exclusive of stop, and that requirement will be shown on the drawings.

****

Doors shall have [narrow] [medium] [wide] stiles and rails as shown, and shall be fabricated from extruded aluminum hollow seamless tubes or from a combination of open-shaped members interlocked or welded together. Doors shall be [single-glazed] [double-glazed and shall have a minimum total average unit thermal resistance of R Value 1.92] [double-glazed and shall have a minimum condensation resistance factor of [_____] in accordance with AAMA 1503.1]. Top and bottom rail shall be fastened together by means of welding or by 3/8 inch diameter plated tensioned steel tie rods. An adjustable mechanism shall be provided in the top rail of narrow stile doors to allow for minor clearance adjustments after installation. [Extruded aluminum snap-in glazing beads] [or] [glazing beads formed of [_____]] shall be provided on interior side of doors. Extruded aluminum theft-proof snap-in glazing beads or fixed glazing beads shall be provided on exterior or security side of doors. Glazing beads shall have vinyl insert glazing gaskets, designed to receive glass of thickness required. Glass is specified in Section 08810 GLASS AND GLAZING.

2.3.2 Flush Doors

****
NOTE: Flush aluminum framed doors with aluminum or fiberglass reinforced polyester (FRP) face panels should be considered for use in industrial facilities and wet areas where exposure to chemical fumes or moisture would cause rapid deterioration of steel or wood doors. Flush doors may also be considered for supply room and similar doors in facilities where rough usage is expected and minimum surface maintenance is required. The FRP faced door is more resistant to chemical or severe environmental conditions than the aluminum faced door.

****

Doors shall be flush aluminum framed [with no glazing] [single-glazed with [aluminum] [gasket] framed vision lites] [double-glazed with [aluminum] [gasket] framed vision lites and shall have a minimum total average unit thermal resistance of R value 1.92] [double-glazed with [aluminum] [gasket] framed vision lites and shall have a minimum condensation resistance factor of [_____] in accordance with AAMA 1503.1]. Doors shall have a core of [foamed-in-place self-extinguishing urethane] [_____]. Core shall be surrounded at edges and openings with extruded aluminum shapes. Facing sheets shall be [0.050 inch aluminum bonded to 1/8 inch thick tempered hardboard backing] [0.050 inch thick aluminum with [embossed pattern] [a plain smooth surface]] [1/8 inch thick fiberglass reinforced polyester (FRP) sheet] and shall be of the color and finish specified. Facing sheets shall be bonded to the core and interlocked with the extruded edge members.

2.4 COLOR, TEXTURE, AND PATTERN

Color, Texture, and pattern shall be in accordance with Section [09915 COLOR SCHEDULE] [_____]

PART 3 EXECUTION

3.1 INSTALLATION OF DOORS, FRAMES, AND ACCESSORIES

3.1.1 Protection of Aluminum

Aluminum shall not be used where it will be in contact with copper or where it will contact water which flows over copper surfaces. Aluminum that will be in contact with wet or pressure-treated wood, mortar, concrete, masonry, or ferrous metals shall be protected against galvanic or corrosive action by one of the following methods.

3.1.1.1 Paint

Aluminum surfaces to be protected shall be solvent cleaned and given a coat of zinc-molybdate primer and one coat of aluminum paint.

3.1.1.2 Nonabsorptive Tape or Gasket

Nonabsorptive tape or gasket shall be placed between the adjoining surfaces and shall be cemented to the aluminum surface using a cement compatible with aluminum.

3.1.2 Installation

Frames and framing members shall be accurately set in position to receive adjoining components. Frames shall be plumb, square, level, and in alignment, and securely anchored to adjacent construction. Metal-to-metal joints between framing members and joints between framing members and building surfaces shall be sealed as specified in Section 07900 JOINT SEALING. Doors shall be accurately hung with proper clearances, and adjusted to operate properly.

****

DEPARTMENT OF THE ARMY | **CEGS-08210 (May 1997)**
U.S. ARMY CORPS OF ENGINEERS | **------------------------**
Superseding
CEGS-08201 (October 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes Special Change (Tailoring Options) (April 1998)
Includes Text Adjustment Change (Section 01300 Reference) (June 1997)

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SECTION 08210

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05/97

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DEPARTMENT OF THE ARMY | **CEGS-08210 (May 1997)**
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GUIDE SPECIFICATION FOR CONSTRUCTION

Includes Special Change (Tailoring Options) (April 1998)
Includes Text Adjustment Change (Section 01300 Reference) (June 1997)

****

SECTION 08210

WOOD DOORS
05/97

****

NOTE: This guide specification covers the requirements for interior and exterior wood doors including wood frames. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for flush doors, panel doors, louver doors, and fire rated doors. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****

NOTE: Drawings will include the following information as applicable:

Location, size, and thickness of doors, elevations showing size and location of glazed openings and

louvers, jamb, and sill details.

Designation of special requirements such as fire resistance rating and sound transmission rating.

Designation of solid-core and hollow-core flush doors.

Designation of solid-core flush doors with medium density overlay or high pressure laminate faces.

Designation of doors to receive field applied paint finish, field applied natural finish, factory applied natural finish, or factory applied paint finish.

Exterior wood doors will be permitted only in sheltered locations. Flush exterior doors will have a solid wood block core. Exterior doors will usually be painted. Medium density overlay will provide the best surface for paint finish on exterior flush doors.

Interior wood doors will be paneled, flush solid-core, flush hollow-core, molded 2, 4, or 6 panel hollow core, or louvered type as required. Finish will be painted or natural as required. Flush doors will normally be solid-core, 44.4 mm (1-3/4 inches) thick. Hollow-core doors 34.9 mm (1-3/8 inch) thick doors are permitted only for light duty applications.

Lead-lined doors are specified in Section 13090 X-RAY SHIELDING.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA 135.4	(1995) Basic Hardboard

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

ARCHITECTURAL WOODWORK INSTITUTE (AWI)

AWI-02	(1994) Architectural Woodwork Quality Standards, Guide Specifications and Quality Certification Program

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3	(1991) High-Pressure Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1995) Fire Doors and Windows
NFPA 101	(1997) Safety to Life from Fire in Buildings and Structures
NFPA 252	(1995) Fire Tests of Door Assemblies

NATIONAL WOOD WINDOW & DOOR ASSOCIATION (NWWDA)

NWWDA I.S. 1-A	(1993) Architectural Wood Flush Doors
NWWDA I.S. 4	(1994) Water-Repellent Preservative Non-Pressure Treatment for Millwork

1.2 GENERAL REQUIREMENTS

****

NOTE: Wood doors will normally be installed in metal frames specified in Section 08110 STEEL DOORS AND FRAMES. For projects where wood door frames are required for aesthetic or other reasons, the applicable following paragraphs will be edited as required to meet project requirements.

****

1.2.1 Standard Products

Doors shall be of the type, size, and design indicated on the drawings, and shall be the standard products of manufacturers regularly engaged in the manufacture of wood doors.

1.2.2 Marking

Each door shall bear a stamp, brand, or other identifying mark indicating quality and construction of the door. The identifying mark or a separate certification shall include identification of the standard on which construction of the door is based, identity of the manufacturing plant, identification of the standard under which preservative treatment, if used, was made, and identification of the doors having a Type I glue bond.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Wood Doors and Frames; [_____].

Drawings indicating the location of each door, elevation of each type of door, details of construction, marks to be used to identify the doors, and location and extent of hardware blocking. Drawings shall include catalog cuts or descriptive data for doors, weatherstripping, flashing, and thresholds to be used.

SD-06 Instructions

Fire Doors; [_____].

Manufacturers preprinted installation and touch-up instructions.

SD-13 Certificates

Fire Rated Doors; [_____]. Adhesives; [_____].

Certificates for oversize fire doors and/or door/frame assemblies stating that the doors are identical in design, materials, and construction to a door that has been tested and meets the requirements for the class indicated. Certificate stating that adhesives used for proposed doors do not contain any formaldehyde.

SD-14 Samples

High Pressure Laminate Doors; [_____]. Factory Coated Natural Finish; [_____]. Factory Coated Paint Finish; [_____].

Samples of factory applied [natural] [paint] [high pressure laminate] finish.

1.4 STORAGE

Doors shall be stored in fully covered areas and protected from damage and from extremes in temperature and humidity. Doors shall be stored on supports to prevent warping or twisting, and to provide ventilation. Factory cartons or wrappers shall be kept intact until installation.

1.5 HARDWARE

Hardware, including weatherstripping and thresholds, is specified in Section 08700 BUILDERS' HARDWARE.

1.6 GLAZING

Glazing is specified in Section [08810 GLASS AND GLAZING] [08840PLASTIC GLAZING].

1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2 PRODUCTS

2.1 GENERAL FABRICATION REQUIREMENTS

2.1.1 Edge Sealing

Wood end-grain exposed at edges of doors shall be sealed prior to shipment.

2.1.2 Preservative Treatment

Exterior softwood doors shall be water-repellent preservative treated in accordance with NWWDA I.S. 4.

2.1.3 Adhesives

Adhesives shall be in accordance with NWWDA I.S. 1-A, requirements for Type I Bond Doors (waterproof) for exterior doors and requirements for Type II Bond Doors (water-repellent) for interior doors. Adhesive for doors to receive a transparent finish shall be nonstaining. Adhesives shall contain no formaldehydes.

2.1.4 Prefitting

Doors shall be furnished prefitted or unfitted at the option of the Contractor, except plastic laminate clad doors shall be furnished prefit in accordance with the standards under which they are produced.

2.1.5 Prehung Units

****

NOTE: Select the type of units required. Delete this paragraph if prehung units are not required for the project.

****

[Interior doors shall be mounted prehung to a solid [Custom] [Premium] [_____] Grade [split] [_____] jamb with 1-1/2 pair of butt hinges.] [Exterior doors shall be mounted prehung to a solid [Custom] [Premium] [_____] Grade [split] [_____] jamb with 1-1/2 pair of butt hinges. Units shall be completely weatherstripped and shall have a metal threshold. Air leakage rate of weatherstripping shall not exceed 0.20 cfm per linear foot of crack when tested in accordance with ASTM E 283 at standard conditions.] Units shall be pre-mortised or pre-drilled and fitted to receive hardware. Standards shall be in accordance with AWI-02 Section 900. Hardware shall be in accordance with Section 08700 BUILDERS' HARDWARE.

2.2 FLUSH DOORS

****

NOTE: Flush doors will normally be the solid-core type. Delete all reference to hollow-core doors where not required for the project.

Specify both 5-ply and 7-ply construction for doors receiving paint finish. Specify only 5-ply construction for natural finished doors.

****

Flush doors shall be [solid core] [or] [hollow core] [as shown] and shall conform to NWWDA I.S. 1-A, except for the one year acclimatization requirement in paragraph T-2, which shall not apply. Wood doors shall be [5-ply] [or] [7-ply] construction with faces, stiles, and rails bonded to the cores.

2.2.1 Core Construction

2.2.1.1 Solid Cores

****

NOTE: The types of solid-core construction specified will provide doors of adequate strength and quality for all normal applications. For very large doors, and for doors subjected to high impact, the vertical edge and horizontal edge bonded core should be specified (see Standards S-5 through S-14 in NWWDA I.S. 1-A). This core may be obtained with the edges bonded to the core.

Where wood doors are specified for EM Barracks and other areas subject to hard usage conditions, the door construction will be limited to solid-core types with wood block cores or particle board core in accordance with past experience for either type door.

Specify the blocking options only for undercutting and specialized hardware operations.

****

Door construction shall be [glued wood block core] [or] [particle board core] [mineral core] with vertical and horizontal edges bonded to the core. Blocking and hardware reinforcements for particle board and mineral core doors shall be blocking option [HB-1-5] [HB-2-5] [HB-4] [HB-6] [_____] in accordance with NWWDA I.S. 1-A.

2.2.1.2 Hollow Cores

****

NOTE: See Standards S-15 and S-16 in NWWDA I.S. 1-A. Specify the blocking options only for

undercutting and specialized hardware operations.
****

Hollow core doors shall be provided with wood stiles, rails, and lock blocks of sufficient width for the application of door mounted hardware. Blocking option shall be [HB-1] [HB-3] [HB-4] [HB-5] [HB-7] in accordance with NWWDA I.S. 1-A.

2.2.2 Face Panels

2.2.2.1 Natural Finished Wood Veneer Doors

****
NOTE: The applicable wood species for natural finish will be selected, and inapplicable wording deleted. For medical facilities and other high-quality installations of solid-core flush doors, the wood veneer will be Premium Grade, book matched, and edge banding will be selected to provide finish matching the face veneer. Premium Grade veneers should be limited to factory coated natural finishes. For facilities where appearance is not critical, "B" Grade face veneers will be specified and the requirements for selected edge banding will be deleted.
****

Veneer doors to receive natural finish shall be [Custom Grade] [Premium Grade, book matched] [birch] [red oak] [white oak] [_____] veneer in accordance with NWWDA I.S. 1-A. Vertical stile strips shall be selected to provide edges of [compatible species] [the same species and/or color as the face veneer.] Door finish shall be in accordance with paragraph [FINISHING] [FIELD FINISHING].

2.2.2.2 Painted Wood Veneer Doors

****
NOTE: Medium density overlay (MDO) on wood veneer will be specified for high-quality exterior installations of solid-core flush doors where paint finish is required.
****

Veneer doors to receive paint finish shall be [Economy Grade] [Economy Grade with medium density overlay] in accordance with NWWDA I.S. 1-A. Door finish shall be in accordance with paragraph [FINISHING] [FIELD FINISHING].

2.2.2.3 High Pressure Laminate Doors

****
NOTE: High pressure laminate faced doors may be specified when fully justified by the service conditions. Laminate faced doors should be considered for hospitals and similar facilities where impact resistance, wear resistance, and cleanability are important considerations.
****

Laminate shall be Grade GP50 in accordance with NEMA LD 3. Exposed door stile edges shall be covered with laminate matching the face panels. Color and pattern of laminate shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

2.2.2.4 Hardboard Face

****

NOTE: Most hardboard faced doors are available unfinished for staining, primed, or prefinish painted. Coordinate with manufacturers for available finishes. Edit paragraph to meet project requirements.

****

Hardboard face panels shall be in accordance with AHA 135.4. Hardboard face panels shall be composed of 1-ply 1/8 inchthick tempered hardboard. Panels shall be [molded interior grade [2] [4] [6] raised panel design] [flush panel [interior] [exterior] grade design] as shown. Vertical stiles shall be [manufacturer's standard softwood] [hardwood]. Doors shall be furnished [[unfinished] [primed] for finishing in accordance with paragraph FIELD FINISHING] [prefinished in accordance with paragraph FINISHING].

2.3 PANEL AND LOUVER DOORS

Panel and louver doors shall conform to AWI-02 Section 1400.

2.3.1 Louvers

Slats shall be not less than 1/4 inch thick. A center mullion shall be provided for flat slat louvers 20 inches or more in width, and for V-slat louvers 24 inches or more in width. Doors shall be adequately blocked to provide solid anchorage for the louvers.

2.3.2 Natural Finished Doors

Doors to receive natural finish shall be [Premium Grade] [or] [Custom Grade] [Hemlock-Fir] [Spruce-Pine-Fir] [_____] in accordance with AWI-02. Finish shall be in accordance with paragraph [FINISHING] [FIELD FINISHING].

2.3.3 Painted Doors

Doors to receive paint finish shall be Custom Grade in accordance with AWI-02. Finish shall be in accordance with paragraph [FINISHING] [FIELD FINISHING].

2.4 FIRE RATED DOORS

****

NOTE: Wood fire doors with a composition mineral core should not be used in areas where the faces may be damaged by cart traffic, impact, or other abuse.

****

Fire rated door assemblies shall bear the listing identification label of a nationally recognized testing laboratory qualified to perform tests of fire door assemblies in accordance with NFPA 252 and having a listing for the tested assemblies. The specific time interval rating on the labels shall be [_____] [as shown]. Door assemblies shall be in accordance with NFPA 80. Listing identification on labels shall be constructed and permanently applied by a method which results in their destruction should they be removed. Fire rated doors shall be [mineral core [45] [60] [90]] [particleboard core [20] [30]] [staved lumber core [20] [30]] [hardboard faced hollow core 20] [stile and rail raised panel 20] minute rating.

2.4.1   Reinforcement Blocking

Fire rated doors shall be provided, as required, with hardware reinforcement blocking, and top, bottom, and intermediate rail blocking. Lock blocks shall be [manufacturer's standard] [not less than 5 inches by 18 inches.] Reinforcement blocking shall be in compliance with the manufacturer's labeling requirements. Reinforcement blocking shall not be of mineral material.

2.4.2   Stile Edges

Composite fire rated doors shall be provided with vertical stile edges that do not contain fire retardant salts. [Vertical stiles shall be of the same species and/or color as the face veneer.] [Stiles shall be special laminated materials type.]

2.5   MOULDING AND EDGING

Moulding and edging shall be as shown. Wood species for transparent finished doors shall be compatible with veneer.

2.6   INSERT LOUVERS

Where indicated, doors shall be provided with [sightproof] [lightproof] insert louvers. Louvers shall be stationary or adjustable as shown. Blades shall be welded or tenoned to the frame and the entire assembly fastened to the door with metal or wood moldings on both sides as shown. The frame shall be nonremovable from the outside of the door.

2.7   WOOD FRAMES

Wood frames shall be provided where shown on the drawings. Wood frames shall be [Premium Grade] [Custom Grade] in species to match door face veneer species. For exterior door openings, frames shall be rabbeted from a solid board to provide an integral stop. For interior frames, applied stops are permitted unless otherwise indicated. Jamb sections shall be dadoed and screwed in place. Finish for frames and trim shall match the doors. Wood frames shall comply with AWI-02 Section 900.

2.8   FINISHING

2.8.1   Factory Coated Natural Finish

****

NOTE: Premium (P) Grade finish should be specified for medical facilities, major headquarters buildings, and other facilities where appearance is a primary consideration. Custom (C) Grade will be specified for other facilities where appearance is not critical. Stain, sheen, and grain effect will be selected to satisfy project requirements.

****

Doors indicated to receive factory coated natural finish shall be given a transparent finish conforming to AWI-02, Section 1500, [Premium] [Custom] Grade, [dark] [medium] [light] stain, [dull rubbed] [medium rubbed] [full gloss] sheen, [open] [close] grain effect. Finish shall be AWI factory finish system Number TR3 or TR4. Color of the natural finish shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____]. Edges of unfitted doors shall be field finished after fitting to the frames.

2.8.2 Factory Coated Paint Finish

Doors indicated to receive factory coated finish shall be given [manufacturer's standard prime coat] [manufacturer's standard paint finish] [an opaque finish conforming to AWI-02, Section 1500, system number OP-6 (catalyzed polyurethane)]. Color of factory coated paint finish shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

PART 3 EXECUTION

3.1 INSTALLATION OF DOORS

3.1.1 General Use Doors

****

NOTE: Additional clearance should be specified at the bottom of doors for areas where carpet or rugs may be used or where return-air is required under doors.

****

Doors shall be fit, hung, and trimmed as required. Door shall have a clearance of 1/8 inch at the sides and top and shall have a bottom clearance of 1/4 inch over thresholds and 1/2 inch at other locations unless otherwise shown. The lock edge or both edges of doors shall be beveled at the rate of 1/8 inchin 2 inches. Cuts made on the job shall be sealed immediately after cutting, using a clear varnish or sealer. Bottom of doors shall be undercut to allow clear door swing over carpeted areas. Vertical edges of doors which have not been rounded or beveled at the factory shall be eased when the doors are installed.

3.1.2 Fire Doors

Installation, hardware, and operational characteristics shall conform to NFPA 80 and NFPA 101 and shall be in strict conformance with the manufacturer's printed instructions. Properly sized pilot holes shall be drilled for screws in door edges. Factory applied labels shall remain intact where installed. Labeled hinge stile edge and top edge of door shall not be trimmed. Lockstile edge and bottom edge may be trimmed only to the extent recommended by the door manufacturer.

3.2 INSTALLATION OF WOOD FRAMES

Frames shall be set plumb and square, and rigidly anchored in place securely seated to floor using finish type nails. Double wedge blocking shall be provided near the top, bottom, and mid-point of each jamb.

3.3 FIELD FINISHING

Doors to receive field finishing, whether paint or natural finish, shall be factory primed or sealed, as required, and then shall be finished in accordance with Section 09900 PAINTING, GENERAL. Factory applied sealer shall not prevent doors from accepting field stain and finish. Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____]. Field touch-up of factory finishes shall be in accordance with manufacturers instructions.

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-08330 (June 1997)**
U.S. ARMY CORPS OF ENGINEERS | **--------------------------**
Superseding
CEGS-08330 (February 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 2 (March 1999)
Includes Special Change (Tailoring Options) (July 1998)

Latest Change indicated by CHG tags

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SECTION 08330

OVERHEAD ROLLING DOORS

06/97

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DEPARTMENT OF THE ARMY | **CEGS-08330 (June 1997)**
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Latest Change indicated by CHG tags

****

SECTION 08330

OVERHEAD ROLLING DOORS
06/97

****

NOTE: This guide specification covers the requirements for overhead rolling doors for commercial use. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for non-insulated curtains, insulated curtains, manual push-up operation, manual hand chain operation, manual crank operation, electric power operation, and fire doors. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 653/A 653M	(1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip process
ASTM E 84	(1997a) Surface Burning Characteristics of Building Materials
ASTM E 330	(1996) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE Fundament HDBK-IP	(1997) Handbook, Fundamentals I-P Edition
ASHRAE Fundament HDBK-SI	(1997) Handbook, Fundamentals SI Edition

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA MG 1	(1993; Rev 1, Rev 2, Rev 3) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
NFPA 80	(1995) Fire Doors and Fire Windows

1.2 DESCRIPTION

****

NOTE: To provide maximum protection from the weather, exterior doors will normally be installed on the interior face of the wall. Weather protection features should be considered for doors installed on the exterior face of the wall.

The appropriate design and fire rating classification will be selected. Depending on the size of the fire door, labelling and oversize certificates and/or labels will vary with the individual manufacturers. Generic installation of a rolling fire door, as shown in NFPA 80 is applicable to masonry type fire walls and the manufacturer's listed procedures, or the authority having jurisdiction. Other wall construction listings such as non-masonry (drywall) will be accomplished per the individual manufacturer's listed procedures or as approved by the authority having jurisdiction. Manufacturer's catalogs should be consulted for required headroom and sideroom.

The following information must be indicated on the project drawings:

a. Size of door openings.

b. Type and details of door frames or jambs plus sideroom, jamb loads and door curtain deflection under pressure load.

c. All wire and conduit from source of power to the operators and/or controls for electric power operated doors.
****

Overhead rolling doors shall be spring counterbalanced, rolling type, with interlocking slats, complete with guides, fastenings, hood, brackets, and operating mechanisms, and shall be designed for use on openings as indicated. Fire doors shall bear the Underwriters Laboratories, Warnock Hersey, Factory Mutual or other nationally recognized testing laboratory label for [Class [_____] rating.] [the rating listed on the drawings.] Each door shall be provided with a permanent label showing the manufacturer's name and address and the model/serial number of the door. Doors in excess of the labelled size shall be deemed oversize and shall be provided with a listing agency oversize label, or a listing agency oversize certificate, or a certificate signed by an official of the manufacturing company certifying that the door and operator have been designed to meet the specified requirements.

1.2.1 Wind Load Requirements

****
NOTE: For exterior doors, applicable wind load values will be determined based on ASCE 7, Minimum Design Loads For Buildings and Other Structures. Wind loads will be determined based on design wind speed, importance factor, exposure classification, mean roof height of the structure, building classification, size of door, wall zone, and impact resistance of the structure's openings.
****

Doors and components shall be designed to withstand the minimum design wind load of [20 psf] [[_____] psf.] Doors shall be constructed to sustain a superimposed load, both inward and outward, equal to 1-1/2 times the minimum design wind load. [Calculations shall be provided that prove the door design meets the design windload requirements.] [Test data showing compliance with design windload requirements for the specific door design tested in accordance with the uniform static air pressure difference test procedures of ASTM E 330 shall be provided.] Recovery shall be at least 3/4 of the maximum deflection within 24 hours after the test load is removed. Sound engineering principles may be used to interpolate or extrapolate test results to door sizes not specifically tested

1.2.2 Operational Cycle Life

****

NOTE: The particular needs of the project are those that will be used to determine frequency of usage. The normal operating frequency for overhead coiling doors is 10 cycles per day. Typical rolling doors are designed for 15,000-20,000 spring cycles. If doors are expected to operate at a significantly higher frequency, the number of cycles per day or hour should be specified.

****

All portions of the door and door operating mechanism that are subject to movement, wear, or stress fatigue shall be designed to operate through a minimum number of [10] [_____] cycles per [day] [hour]. One complete cycle of door operation is defined as when the door is in the closed position, moves to the full open position, and returns to the closed position.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Overhead Rolling Door Unit; [_____].

Manufacturer's catalog data, test data, and summary of forces and loads on the walls/jambs.

SD-04 Drawings

Overhead Rolling Door Unit; [_____].

Drawings showing the location of each door including schedules. Drawings shall include elevations of each door type, details and method of anchorage, details of construction, location and installation of hardware, shape and thickness of materials, details of joints and connections, and details of guides, power operators, controls, and other fittings.

SD-06 Instructions

Overhead Rolling Door Unit; [_____].

Manufacturer's preprinted installation instructions.

SD-09 Reports

Tests; [_____].

Written record of fire door drop test.

SD-13 Certificates

Fire Doors; [_____].

Oversize labels or certificates stating that the overhead rolling doors conform to requirements of this section. Certificates for oversize fire doors stating that the doors and hardware are manufactured in compliance with the requirements for doors of this type and class and have been tested and meet the requirements for the class indicated. Certificate is not required when fire door has a listing agency label or oversize label on the door bottom bar.

SD-14 Samples

Overhead Rolling Door Unit; [_____].

Manufacturer's standard color samples of factory applied finishes.

SD-19 Operation and Maintenance Manuals

Operation Manual; [_____].

Maintenance and Repair Manual ; [_____].

[Six] [_____] copies of the [system operation manual] [and] [system maintenance and repair manual] for each type of door and control system.

1.4 DELIVERY AND STORAGE

Doors shall be delivered to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon. Doors shall be stored in a dry location that is adequately ventilated and free from dirt and dust, water, and other contaminants, and in a manner that permits easy access for inspection and handling.

1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1-year period shall be provided.

1.6 OPERATION AND MAINTENANCE MANUALS

Operating instructions outlining the step-by-step procedures required for motorized door and shutter operation for the overhead rolling door unit shall be provided. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, troubleshooting guides, and simplified diagrams for the equipment as installed shall be provided. A complete list of parts and supplies, source of supply, and a list of the high mortality maintenance parts shall be provided.

PART 2 PRODUCTS

2.1 OVERHEAD ROLLING DOORS

Doors shall be surface-mounted type with guides at jambs set back a sufficient distance to clear the opening. Exterior doors shall be mounted [as indicated.] [on interior side of walls.]

2.1.1 Curtains

The curtains shall roll up on a barrel supported at the head of opening on brackets, and shall be balanced by helical torsion springs. [[Steel] [stainless steel] slats for doors less than 15 feet wide shall be minimum bare metal thickness of 0.0269 inches.] [[Steel] [stainless steel] slats for doors from 15 feet wide to 21 feet wide shall be minimum bare metal thickness of 0.0329 inches.] [[Steel] [stainless steel] slats for doors 21 feet wide and wider shall be minimum bare metal thickness of 0.0438 inches.] [Aluminum slats for doors up to 18 feet 4 inches wide shall be minimum 0.050 inches.] Slats shall be of the minimum bare metal decimal thickness required for the width indicated and the wind pressure specified above. Slats for fire doors over 12 feet wide and under 20 feet wide shall be not less than 0.0329 inches steel. Slats for fire doors 20 feet wide or wider shall be not less than 0.0438 inches steel.

2.1.1.1 Non-Insulated Curtains

****

NOTE: Where physical abuse of the doors may be a problem, the minimum decimal thickness of material (bare metal) should be specified for the various door widths. If physical abuse is not a factor, the decimal thickness of material may be determined by wind pressure alone and the references to door width will be deleted. The referenced bare metal thicknesses do not include galvanization or paint coating thicknesses.

****

Curtains shall be formed of interlocking slats of shapes standard with the manufacturer. Slats for exterior doors shall be flat type.

2.1.1.2   Insulated Curtains

****

NOTE: Several manufacturers can provide insulated slats that comply with all specified requirements. Check manufacturers' literature for information on R-value. At least one manufacturer makes an oversize slat that provides increased insulation.

Insulated slats will not be specified for fire doors.

****

The slat system shall supply a minimum R-value of 4 [_____] when calculated in accordance with ASHRAE Fundament HDBK-IP ASHRAE Fundament HDBK-SI. Slats shall be of the flat type as standard with the manufacturer. Slats shall consist of a [urethane] [polystyrene] core not less than 11/16 inch thick, completely enclosed within metal facings. Exterior face of slats shall be gauge as specified for curtains. Interior face shall be not lighter than 0.0209 inches. The insulated slat assembly shall have a flame spread rating of not more than 25 and a smoke development factor of not more than 50 when tested in accordance with ASTM E 84.

2.1.2   Endlocks and Windlocks

The ends of each alternate slat for interior doors shall have [steel] [iron] endlocks of manufacturer's stock design. [Endlocks shall be provided in accordance with manufacturer's listing on fire doors when required by test results performed by the code listing agency.] [In addition to endlocks, non-rated exterior doors shall have the manufacturer's standard windlocks as required to withstand the wind load. Windlocks shall prevent the curtain from leaving guides because of deflection from specified wind pressure.]

2.1.3   Bottom Bar

The curtain shall have a [standard] [off-set] [sloped] bottom bar consisting of [two hot-dip galvanized steel angles for steel doors.] [two aluminum angles for aluminum doors.] [extruded aluminum T-shape.] A sensing edge shall be attached to the bottom bar of doors that are electric-power operated.

2.1.4   Guides

****

NOTE: Wind load forces acting on the coiling (rolling) door slats may cause severe tensile loadings at the door jambs. The magnitude of these tensile loads should be evaluated. Door jamb construction and door guide fastening must be designed to withstand the anticipated tensile loads. Omit the requirement for the detailed written analysis of forces and loads if not required. Omit all text relating to equipment for hazardous areas if not required for the project.

****

Guides shall be steel structural shapes or formed steel shapes, of a size and depth to provide proper clearance for operation and resistance under the design windload. Guides shall be attached to adjoining construction with fasteners recommended by the manufacturer. Spacing of fasteners shall be as required to meet the minimum design windload. Doors and guides in hazardous areas shall have static grounding.

2.1.5 Barrel

The barrel shall be steel pipe or commercial welded steel tubing of proper diameter for the size of curtain. Deflection shall not exceed 0.03 inch per foot of span. Ends of the barrel shall be closed with metal plugs, machined to fit the pipe. Aluminum plugs are acceptable on non-fire door barrels.

2.1.6 Springs

****
NOTE: Coordinate with manufacturer's literature to determine the amount of sideroom required for spring tension adjustment.
****

Oil tempered helical steel counter-balance torsion springs shall be installed within the barrel and shall be capable of producing sufficient torque to assure easy operation of the door curtain. Access shall be provided for spring tension adjustment from outside of the bracket without removing the hood.

2.1.7 Brackets

Brackets shall be of steel plates to close the ends of the roller-shaft housing, and to provide mounting surfaces for the hood. An operation bracket hub and shaft plugs shall have sealed prelubricated ball bearings.

2.1.8 Hoods

Hoods shall be [steel] [stainless steel] [aluminum] with minimum bare metal thickness of 0.0209 inches formed to fit contour of the end brackets, and shall be reinforced with steel rods, rolled beads, or flanges at top and bottom edges. Multiple segment and single piece hoods shall be provided with support brackets of the manufacturer's standard design as required for adequate support.

2.1.9 Weatherstripping

Exterior doors shall be fully weatherstripped. A compressible and replaceable weather seal shall be attached to the bottom bar. Weather seal at door guides shall be continuous vinyl or neoprene, bulb or leaf type, or shall be nylon-brush type. A weather baffle shall be provided at the lintel or inside the hood. Weatherstripping shall be easily replaced without special tools.

2.1.10 Slat Openings

2.1.10.1 Vision Lites

Vision lites shall be those standard for the manufacturer. The lite assembly shall consist of [3 separate lites across and 5 slats high]

[_____]. Opening shall have manufacturer's standard acrylic coverings.

2.1.10.2   Ventilation/Vision Perforations

Perforations shall be manufacturer's standard design and size. Weather stripping for door guides and hoods shall be omitted from perforated doors.

2.1.11   Operation

****

NOTE: The required method of operation will be shown on the drawings. Electric operation should be considered for large doors, as the controlled operating action will extend the life of the door. The indicated lifting force should be adequate unless conditions dictate that it be less. Manual push-up operation should be limited to doors not exceeding 2.4 m (8 feet) high or 7.4 square meters (80 square feet) in area. Omit all text relating to equipment for hazardous areas if not required for the project.

****

Doors shall be operated by means of [manual [push-up] [hand-chain] [crank] [with provision made for future installation of electric power]] [electric power with auxiliary chain hoist]. Equipment shall be designed and manufactured for usage in [non-hazardous] [hazardous Class [_____], Division [_____], and Group [_____] areas].

2.1.11.1   Manual Push-Up Operation

One lifting handle shall be provided on each side of the door. The maximum force required for lift-handle operation shall not exceed 25 pounds. Pull-down straps or pole hooks shall be provided on bottom rail of doors over 7 feet high.

2.1.11.2   Manual Hand-Chain Operation

Operation shall be by means of a [galvanized] [bronze (in hazardous areas)] endless chain extending to within 3 feet of floor. Reduction shall be provided by use of roller chain and sprocket drive or suitable gearing, to reduce the pull required on hand chain to not over 35 pounds. Gears shall be high grade gray cast iron.

2.1.11.3   Manual Crank Operation

Operation shall be by means of a vertical shaft, gear box, and [crank located approximately 34 inches above the floor] [or] [reduction gearing and awning type handle]. Gears shall be of high grade gray cast-iron. Gear reduction shall be provided to reduce pressure exerted on the crank to not over 35 pounds.

2.1.11.4   Electric Power Operator With Auxiliary Chain Hoist Operation

****

NOTE: When power operators are specified, project drawings must indicate location of motors and control switches. Three-phase motors will be

provided whenever three-phase electrical service is specified. The control switch stations will be located within the building, at least 1.5 m (5 feet) above the floor line. One control switch will be placed about 0.6 m (2 feet) from the door jamb track. Where dual control switches are necessary for the same door, the second switch control station will be located so the operator will have complete visibility of the door. Select "necessary means of reduction for medium-duty doors"; for doors less than 4.8 x 4.8 m (16 x 16 foot) used 1 to 2 times daily. Select "self-locking worm gear in oil bath for heavy-duty doors"; for doors 4.8 x 4.8 m (16 x 16 foot) or over used 3 times or more daily.

The term "Controls" refers to the electrical push button, key operated control stations. Requirements of hazardous environment should be exactly specified in terms of compliance with NFPA 70, Article 501, 502, 503, or 504. The motor, limit switches, reversing starter, or some other component requiring enclosures greater than NEMA 1 should be exactly specified.

Pneumatic sensing edge devices generally require more maintenance and are more likely to have malfunctions than electric sensing edge devices. The pneumatic device should be used when avoidance of electrical devices is critical. The electric sensing edge can be standard or fail-safe. The standard design must be tested daily to insure proper operation. The fail-safe design will not allow electric operation of the door if the sensing edge or wiring is defective. This reflects a common industry advisory statement.

****

Electric power operators shall be heavy-duty industrial type. The unit shall operate the door through the operational cycle life specified. The electric power operator shall be complete with electric motor, auxiliary operation, [necessary means of reduction for medium-duty doors,] [self-locking worm gear in oil bath for heavy-duty doors,] brake, mounting brackets, push button controls, limit switches, magnetic reversing starter, and all other accessories necessary to operate components specified in other paragraphs of this section. The operator shall be so designed that the motor may be removed without disturbing the limit-switches settings and without affecting the emergency chain operator. Doors shall be provided with an auxiliary operator for immediate emergency manual operation of the door in case of electrical failure. Auxiliary operation shall be by means of [galvanized] [bronze (in hazardous areas)] endless chain extending to within 3 feet of the floor. The emergency manual operating mechanism shall be so arranged that it may be operated from the floor without affecting the settings of the limit switches. A mechanical device shall be included that will disconnect the motor from the drive operating mechanism when the auxiliary operator is used. Where control voltages differ from motor voltage, a control voltage transformer shall be provided in and as part of the electric power operator system. Control voltage shall not exceed 120 volts.

a. Motors: Drive motors shall conform to NEMA MG 1, shall be high-starting torque, reversible type, and shall be of sufficient horsepower and torque output to move the door in either direction from any position at a speed range of 6 to 8 inches per second without exceeding the rated capacity. Motors shall be suitable for operation on [_____] volts, [60] [_____] hertz, [single] [3-] phase current and shall be suitable for across-the-line starting. Motors shall be designed to operate at full capacity over a supply voltage variation of plus or minus 10 percent of the motor voltage rating. Motors shall be provided with overload protection.

b. Controls: Control equipment shall conform to NEMA ICS 2. Enclosures shall conform to NEMA ICS 6, Type 12 (industrial use), Type 7 or 9 in hazardous locations, in accordance with NFPA 70. Exterior control stations shall be weatherproof key-operated type with corrosion-resistant cast-metal cover. Each control station shall be of the three position [button] [or] [switch] type, marked "OPEN," "CLOSE," and "STOP." The "OPEN" and "STOP" controls shall be of the momentary contact type with seal-in contact. The "CLOSE" control shall be of the [momentary contact type] [constant pressure type]. When the door is in motion and the "STOP" control is pressed, the door shall stop instantly and remain in the stop position; from the stop position, the door shall be operable in either direction by the "OPEN" or "CLOSE" controls. Controls shall be of the full-guarded type to prevent accidental operation. Readily adjustable limit switches shall be provided to automatically stop the doors at their fully open and closed positions.

c. Sensing Edge Device: The bottom edge of electric power operated doors shall have [an electric] [a pneumatic] sensing edge for [hazardous] [non-hazardous] areas that will reverse the door movement upon contact with an obstruction and cause the door to return to its full open position. The sensing edge shall not substitute for a limit switch. Exterior doors shall be provided with a combination compressible weather seal and sensing edge.

d. Electrical Work: Conduit and wiring necessary for proper operation shall be provided under Section 16415 ELECTRICAL WORK, INTERIOR. Flexible connections between doors and fixed supports shall be made with flexible type SJO cable, except in hazardous locations where wiring shall conform to NFPA 70, as appropriate. The cable shall have a spring-loaded automatic take up reel or a coil cord equivalent device.

2.1.12 Inertia Brake

****

NOTE: This should be an optional item because of the expense. Omit the paragraph if the brakes are not required. A mechanical inertia brake should be specified only for doors which have a high frequency of usage. This type of mechanism does not provide protection against failure of the pipe or pipe shaft. Selection of the brake unit size should be based on maximum moment force for the door. Inertia brakes have an opening and closing speed limit depending on the door size. Review the manufacturer policy regarding requirement for factory reset of

inertia brake following one or more than one activation of the brake unit. Selection of brake size is based on the force required to stop the door. Factory reset is per the manufacturer's recommendations.
****

Overhead rolling door shall have a mechanical inertia brake device which will stop the door from free fall in any position, should there be a failure in the motor operator brake or roller chain drive. The unit shall be capable of being reset with a back drive action.

2.1.13 Locking

Locking shall consist of [interior slide bolts, suitable for padlock by others, for manual push-up doors] [chain lock keeper, suitable for padlock by others, for chain operated doors] [locking disc or slide bolt, suitable for padlock by others, for crank operated doors]. Locking for motor operated doors shall consist of self-locking gearing [and optional master keyed cylinder with electrical interlock] [with chain lock for emergency hand chain].

2.1.14 Finish

****
NOTE: G90 galvanized coating without baked on primer coat may be selected for steel exterior and interior doors subject to high moisture. G60 galvanized coating with baked-on primer coat and finish coat may be selected for most applications because of its superiority. Generally, there is no advantage to using the heavier G90 galvanizing under baked-on paint systems.
****

[Steel slats and hoods shall be hot-dip galvanized [G90 in accordance with ASTM A 653/A 653M,] [G60 in accordance with ASTM A 653/A 653M,] and shall be treated for paint adhesion and shall receive a [factory baked-on finish coat] [factory baked-on prime coat for field finishing]. The paint system shall withstand a minimum of [1500] [_____] hours without blistering, bubbling, or rust.] [Aluminum slats and hoods shall receive a [mill] [clear anodized] [color anodized] finish.] [Stainless steel slats and hoods shall receive a [#2 B] [#4] finish.] Surfaces other than slats, hood, and faying surfaces shall be cleaned and treated to assure maximum paint adherence and shall be given a factory dip or spray coat of rust inhibitive metallic oxide or synthetic resin primer. Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [white] [brown] [gray] [_____].

2.2 FIRE DOORS

****
NOTE: Activation of the automatic closing device on fire rated doors shall be by the building's fire alarm system when doors are located in smoke barriers, horizontal exits, or where life safety would be endangered by fire and smoke if the doors were left open. Fusible link devices will only be

used in those areas where protection of property from fire is the only consideration. The NFPA 101 Life Safety Code should be consulted to determine acceptability of coiling fire doors in association with means of egress.
****

Fire rated rolling doors shall be provided at locations shown on the drawings. Fire doors shall conform to the requirements specified herein and to NFPA 80 for the class indicated. Doors shall bear the label or oversize label, or be provided with oversize certification of a recognized testing agency indicating the listed rating for the fire door. The construction details necessary for the listed rating shall take precedence over conflicting details shown or specified herein. Fire doors shall be complete with hardware, accessories, and automatic closing device. An automatic closing device shall operate upon [the fusing of a 165 degree F replaceable fusible link.] [activation of the building's fire alarm system.]

PART 3 EXECUTION

3.1 INSTALLATION

Doors shall be installed in accordance with approved detail drawings and manufacturer's instructions. Anchors and inserts for guides, brackets, [motors,] [switches,] hardware, and other accessories shall be accurately located. Upon completion, doors shall be free from warp, twist, or distortion. Doors shall be lubricated, properly adjusted, and demonstrated to operate freely. Fire doors shall be installed in conformance with the requirements of NFPA 80 and the manufacturer's instructions.

3.2 FIELD PAINTED FINISH

Steel doors and frames shall be field painted in accordance with Section 09900 PAINTING, GENERAL. Weatherstrips shall be protected from paint. Finish shall be free of scratches or other blemishes. Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

3.3 TESTS

The fire doors shall be drop tested in accordance with NFPA 80 to show proper operation and full automatic closure and shall be reset in accordance with the manufacturer's instructions. A written record of initial test shall be provided to the Contracting Officer.

-- End of Section --

****

DEPARTMENT OF THE ARMY | **CEGS-08360 (August 1997)**
U.S. ARMY CORPS OF ENGINEERS | **-------------------------**
Superseding
CEGS-08360 (February 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes Special Change (Tailoring Options) (July 1998)

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08/97

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PART 3 EXECUTION

3.1 INSTALLATION

-- End of Section Table of Contents --

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SECTION 08360

SECTIONAL OVERHEAD DOORS
08/97

****

NOTE: This guide specification covers the requirements for industrial grade sectional overhead doors for use on warehouses, shop buildings, and similar facilities. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for aluminum doors, steel doors, wood doors, insulated sandwich doors, manual push-up operation, manual chain hoist operation, and electric power operation. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in

project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 229/A 229M	(1993) Steel Wire, Oil-Tempered for Mechanical Springs
ASTM A 653/A 653M	(1996) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 117	(1995) Operating Salt Spray (Fog) Apparatus
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM E 330	(1990) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1995) Minimum Design Loads for Buildings and Other Structures

DOOR AND ACCESS SYSTEM MANUFACTURERS ASSOCIATION (DASMA)

DASMA 102	(1996) Specifications for Sectional Overhead Type Doors
DASMA 105	(1992) Test Method for Thermal Transmittance and Air Infiltration of Garage Doors

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 501	(1988) Metal Finishes Manual for Architectural and Metal Products; Section: Finishes for Aluminum

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems,

	Enclosures
NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

NATIONAL WOOD WINDOW & DOOR ASSOCIATION (NWWDA)

NWWDA I.S. 4	(1994) Water-Repellent Preservative Non-Pressure Treatment for Millwork

1.2 DESCRIPTION

****

NOTE: The applicable type of door operation will be selected based on available headroom and operational requirements. Types not required will be deleted. If more than one type is required, the types should be shown on the drawings.

Check the mechanical and electrical drawings to ensure that the door in its horizontal position and track suspension framing will not interfere with the installation of fixtures or equipment.

The following information must be indicated on the project drawings:

a. Size of door openings.

b. Type and details of door frames or jambs, plus sideroom and headroom.

c. Wire and conduit from source of power to the operators and/or controls for electric powered doors.

d. Type of lift required. Consult manufacturer's catalogs for required headroom and backroom. Space occupied by the door in the horizontal position should be indicated, to reduce conflicts with light fixtures and mechanical outlets.

****

Sectional overhead doors shall conform to DASMA 102 and the requirements specified herein. Sectional overhead doors shall be of the [standard lift type designed to slide up and back into a horizontal overhead position] [low headroom type designed to slide up and back into a horizontal overhead position] [high lift type designed to slide up and back into a combination horizontal and vertical position] [vertical lift type designed to slide upward into a vertical position] [follow-the-roof lift type designed to slide up and back into a position parallel to the slope of the adjoining roof]. Each door shall be provided with a permanent label showing the manufacturer's name and address and the model/serial number of the door.

1.2.1 Wind Load Requirements

****
NOTE: For exterior doors, the applicable wind speed will be determined according to EI01S010, Load Assumptions for Buildings. Wind loads shall be determined based on design wind speed, importance factor, exposure classification, mean roof height of the structure, building classification, size of door, wall zone, and impact resistance of the structure's openings.
****

Doors and components shall be designed to withstand wind loads determined by procedures in ASCE 7 and a wind speed of [_____] mph. Doors shall be constructed to sustain a superimposed load, both inward and outward, equal to 1-1/2 times the minimum design wind load. The door shall support the superimposed loads for a minimum period of 10 seconds without evidence of serious damage and shall be operable after conclusion of the tests. [Calculations shall be provided that prove the door design meets the design windload requirements.] [Test data showing compliance with design windload requirements for the specific door design tested in accordance with the uniform static air pressure difference test procedures of ASTM E 330 shall be provided.]

1.2.2 Operation Cycle Life

****
NOTE: Industrial doors are defined by DASMA 102 as doors that will be operated in excess of 5,000 cycles per year. On this basis, the 50,000 cycle springs should be expected to provide at least 10 years of service. Where longer operational life is required, where doors will be operated at greater frequency rates, or where the door operation is critical to facility use, springs with greater life expectancy should be specified. Consult the factory.
****

Doors shall be equipped with torsion springs designed to operate through a minimum of [50,000] [75,000] [100,000] cycles. One complete cycle of the door begins with the door in the closed position. The door is then moved to the open position and back to the closed position.

1.3 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Sectional Overhead Door Unit; [_____].

Manufacturer's catalog data, test data, and summary of forces and loads on walls/jambs.

SD-04 Drawings

Sectional Overhead Door Unit; [_____].

Drawings showing the location of each door including schedules. Drawings shall include elevations of each door type; details and method of anchorage; details of construction; method of assembling sections; location and installation of hardware; shape and thickness of materials; details of joints and connections; and details of tracks, rollers, power operators, controls, and other fittings.

SD-06 Instructions

Sectional Overhead Door Unit; [_____].

Manufacturer's preprinted installation instructions.

SD-13 Certificates

Design; [_____].

Manufacturer's certificates stating that the doors and operators have been designed to meet the specified requirements.

SD-19 Operation and Maintenance Manuals

Sectional Overhead Door Unit; [_____].

[Six] [_____] complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions shall include simplified diagrams for the equipment as installed. Also spare parts data for each different item of material and equipment specified, including a complete list of parts and supplies, source of supply, and a list of high mortality maintenance parts. [Six] [_____] complete copies of operation instructions outlining the step-by-step procedure required for motorized door and shutter operation. The instructions shall include the manufacturer's name, model/serial number, service manual, parts list, and brief description of all equipment and their basic operating features.

1.4 DELIVERY AND STORAGE

Doors shall be delivered to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon. Doors shall be stored in a dry location that is adequately ventilated and free from dust or water, and in a manner that permits easy access for inspection and handling. Doors shall be handled carefully to prevent damage to the faces, edges, and ends. Damaged items that cannot be restored to like-new condition shall be replaced.

1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1-year period shall be provided.

PART 2 PRODUCTS

2.1 SECTIONAL OVERHEAD DOORS

2.1.1 Door Section Materials

****

NOTE: The preferred door panel material should be selected, and the remaining materials deleted. Durability, appearance, availability, and maintenance should be considered.

****

Sectional overhead door sections shall be of the height indicated or the manufacturer's standard, but the height of an intermediate section shall not exceed 24 inches. Bottom sections may be varied to suit door height but shall not exceed 30 inches in height. Meeting rails shall have interlocking joints to provide weatherproof closure and to assure alignment for the full width of the door.

2.1.1.1 Aluminum Doors

Aluminum extrusions shall conform to ASTM B 221. Aluminum sheet shall conform to ASTM B 209, alloy and temper best suited for the purpose. Door sections shall be of panel construction with extruded aluminum stiles and rails and aluminum panels. Stiles and rails shall have a minimum wall thickness of 0.060 inch except that intermediate stiles shall have a minimum wall thickness of 0.050 inch. Single sheet aluminum panels shall be not less than 0.050 inch in thickness and shall be installed using a continuous aluminum or vinyl snap-in molding.

2.1.1.2 Steel Doors

Door sections shall be single skin with integral joint, and shall be formed of hot-dipped galvanized steel. Panels shall be constructed of galvanized steel not lighter than [16 gauge with flush surface] [or] [20 gauge with longitudinal integral reinforcing ribs] [or] [24 gauge with longitudinal integral reinforcing ribs and flat bottom V-grooves].

2.1.1.3 Wood Doors

Stiles and rails shall be of Douglas fir, Sitka spruce, or West Coast hemlock, and shall be of mortise-and-tenon construction with waterproof glue and steel pins. Top and bottom rails and end stiles shall be 5-1/4 inches minimum; center stiles shall be 3-1/2 inches minimum; and each center rail shall be a minimum of 2-1/2 inches wide with an overall width per pair of 121 mm^.\ \~4-3/4 inches~.\ Panel rails shall be machined to form a weather tight joint between panels.

a. Panel Sections: Stiles and rails shall be a minimum of 1-3/4 inches thick, and shall be rabbeted to receive the panels. Panels shall be of 1/4 inch tempered hardboard or plywood, secured on the interior side of the door with moldings.

b. Flush Sections: Stiles and rails shall be a minimum of 1-1/2 inches thick. Both surfaces shall be faced with 1/8 inch thick tempered hardboard bonded to honeycomb or insulation core and to stiles and rails with water-resistant adhesive.

2.1.1.4 Insulated Sandwich Doors

Door sections shall be composite construction of 2 separate steel skins (inner and outer) bonded to a foam core, such as expanded/extruded polystyrene or CFC-free polyurethane. Steel skins shall be separated by a thermal break (minimal or no metal to metal contact). Steel shall have a minimum wall thickness of 0.010 inch.

2.1.2 Insulated Sections

****

NOTE: Several manufacturers can provide insulated sections that comply with all specified requirements. Check manufacturer's literature for information on R-Value. At least one manufacturer makes an oversize section that provides increased insulation.

****

The panel sections shall supply a minimum R-Value of [4.0] [7.5] [_____] when tested in accordance with DASMA 105. Panels shall be of the type standard with the manufacturer. Sections shall consist of a chlorofluorocarbon free urethane or polystyrene core not less than 1-3/8 inch thick, completely enclosed within [metal] [hardboard] facings. Exterior face of sections shall be as specified. Interior face shall have a minimum wall thickness of 0.010 inch steel, 0.125 inch hardboard, or 0.032 inch aluminum.

2.1.3 Tracks

****

NOTE: The 76 mm (3 inch) track is specified for stability, and not solely on the basis of door weight. A 51 mm (2 inch) track may be suitable for 2.4 m (8 foot) wide doors of standard windloading.

****

Tracks shall be the manufacturer's standard [2 inch] [3 inch] track, formed of galvanized steel not lighter than 14 gauge for 2 inch track and 2.7 mm^.\ 12 gauge~ for 3 inch track.\ Vertical tracks shall be attached to continuous steel angles not lighter than 11 gauge, installed on the walls, and shall be inclined through the use of adjustable brackets to provide a weathertight closure. Horizontal track shall be reinforced with galvanized-steel angles and shall be supported from overhead structural members and cross braced as required to provide a rigid installation.

2.1.4 Hardware

Heavy duty hinges, brackets, rollers, locking devices, and other hardware required for a complete installation shall be provided. Roller brackets and hinges shall be of minimum 14 gauge galvanized steel, and shall be securely attached to stiles with sheet metal screws or through bolts or with sheet metal screws into minimum 16 gaugestiles. Double hinges shall be provided at ends of panels for doors more than 16 feet wide. Rollers shall be provided with a minimum of 10 ball bearings. Doors shall be reinforced at roller-hinge connections.

2.1.5 Counterbalancing

Doors shall be counterbalanced by means of helical-wound torsion springs mounted on a steel shaft. Springs shall be oil-tempered springwire conforming to ASTM A 229/A 229M. Springs shall be adjustable, and shall be connected to doors with cable having a safety factor of at least 5 to 1.

2.1.6 Weatherstripping

Exterior doors shall be provided with weatherproof joints between sections. Head and jambs shall be provided with rubber or vinyl bulb or leaf type weatherstripping, or with nylon-brush type weatherstripping. Bottom of door shall be provided with a compressible neoprene, rubber, or vinyl weather seal. Weatherstripping shall be adjustable. On electric power operated doors, the bottom seal shall be a combination weather seal and sensing edge.

2.1.7 Pilot Doors

****

NOTE: Pilot doors will not be provided where personnel access doors can be located in a wall near the overhead door. Pilot doors are not acceptable as required fire exits.

****

Pilot doors shall be provided in overhead doors as indicated, and shall be of construction similar to the overhead door. Hardware shall include a 6-pin cylinder lockset keyed into the building keying system, and shall have either spring hinges or a hydraulic door closer.

2.1.8 Vision Lites

Vision lites shall be manufacturer's standard design and size as shown. The openings shall be glazed with [0.125 inch DSB glass] [1/8 inch thick acrylic] [0.750 inch insulated double glazing] with rubber gaskets or thermoplastic frame. Aluminum full view section shall be glazed with [0.125 inch DSB glass] [0.500 inch insulated double glazing].

2.1.9 Operation

****

NOTE: Select the type of door operator required for the facility, and delete inapplicable types. Electric power door operators should be considered for all large or heavy doors. Door life will be extended by the controlled door movement provided by electric operators. Omit all text relating to equipment for hazardous areas if not required for

the project.
****

Doors shall be operated by means of [manual push-up] [manual chain hoist] [manual chain hoist with provision made for future installation of electric power] [electric power with auxiliary chain hoist]. Equipment shall be designed and manufactured for usage in [non-hazardous] [hazardous Class [_____], Division [_____], and Group [_____]] areas.

2.1.9.1 Manual Push-Up Operation

One lifting handle shall be provided on each side of the door. The maximum force required for lift-handle operation shall not exceed 25 pounds. Pull-down strap or rope shall be provided for doors over 7 feet high.

2.1.9.2 Manual Chain Hoist Operation

Operation shall be by means of a [galvanized] [cadmium plated] [bronze (in hazardous areas),] endless chain operating over a sprocket and extending to within 3 feet of the floor. Reduction shall be provided by use of roller chain and sprocket drive or suitable gearing, to reduce the pull required on hand chain to not over 35 pounds. Gears shall be high grade gray cast iron.

2.1.9.3 Electric Power With Auxiliary Chain-Hoist Operation

****
NOTE: When electric power operators are required, the project drawings will indicate the location of motors and control switches. Three-phase motors will be provided whenever 3-phase electrical service is specified. The control switch stations will be located within the building, at least 1500 mm (5 feet) above the floor line. One control switch will be placed about 600 mm (2 feet) from the door jamb, guide, or track. Where dual control switches are necessary for the same door, the second switch control station will be located so the operator will have complete visibility of the door at all times.

The term "Controls" refers to the electrical push button, key operated control stations. Requirements of hazardous environment shall be exactly specified in terms of compliance with NFPA 70, Article 501, 502, 503 or 504. The motor, limit switches, reversing starter, or some other component requiring enclosures greater than listed in NEMA MG 1 shall be exactly specified.
****

Electric power operators shall be heavy-duty industrial type. The unit shall operate the door through the operational cycle life specified. The electric power operator shall be complete with electric motor, auxiliary operation, necessary means of reduction, magnetic brake, brackets, push button controls, limit switches, magnetic reversing starter, and other accessories necessary to operate components specified in other paragraphs of this section. Trolley type operators shall be used on standard lift and low headroom tracks. Jackshaft type operators shall be used on vertical lift and high lift tracks. The operator shall be designed so that the motor may be removed without disturbing the limit-switch settings and without affecting the emergency chain operator. Doors shall be provided with an auxiliary operator for immediate emergency manual operation of the door in case of electrical failure. The emergency manual operating mechanism shall be arranged so that it may be operated from the floor without affecting the timing of the limit switches. A mechanical device shall be included that will disconnect the motor from the drive operating mechanism when the auxiliary operator is used. Operation shall be by means of [galvanized] [bronze (in hazardous areas)] endless chain operating over a sprocket and extending to within 3 feet of the floor. Operating force shall not exceed 35 pounds for hand chain and hand crank. Where control voltages differ from motor voltage, a control voltage transformer shall be provided in and as part of the electric power operator system. Control voltage shall not exceed 120 volts.

a. Motors: Drive motors shall conform to NEMA MG 1, shall be high-starting torque, reversible type, and shall be of sufficient horsepower and torque output to move the door in either direction from any position at a speed range of 6 to 8 inches per second without exceeding the rated capacity. Motors shall be suitable for operation on [_____] volts, [60] [_____] hertz, [single] [3-] phase current and shall be suitable for across-the-line starting. Motors shall be designed to operate at full capacity over a supply voltage variation of plus or minus 10 percent of the motor voltage rating. Motors shall be provided with overload protection.

b. Controls: Control equipment shall conform to NEMA ICS 2. Enclosures shall conform to NEMA ICS 6, Type 12 (industrial use), Type 7 or 9 in hazardous locations, and shall be in accordance with NFPA 70. Exterior control stations shall be weatherproof key-operated type with corrosion-resistant cast-metal cover. Each control station shall be of the 3-position [button] [or] [switch] type, marked "OPEN," "CLOSE," and "STOP." The "OPEN" and "STOP" controls shall be of the momentary contact type with seal-in contact. The "CLOSE" control shall be of the [momentary contact type] [constant pressure type]. When the door is in motion and the "STOP" control is pressed, the door shall stop instantly and remain in the stop position; from the stop position, the door shall be operable in either direction by the "OPEN" or "CLOSE" controls. Controls shall be of the full-guarded type to prevent accidental operation. Readily adjustable limit switches shall be provided to automatically stop the doors at their fully open and closed positions. Pilot doors shall have an interlock switch connected to prevent operation of the power unit if the pilot door is not fully closed.

c. Sensing Edge Device: The bottom edge of electric power operated doors shall have a sensing edge that will immediately [reverse] [or] [stop] the door movement upon contact with an obstruction and cause the door to return to its full open position. The sensing edge shall not substitute for a limit switch. Exterior doors shall be provided with a combination compressible weather seal and sensing edge. The sensing edge shall be an electrical type for [hazardous] [non-hazardous] areas with components connected in series to assure the edge is operable before the door will open.

d. Electrical Work: Conduit and wiring necessary for proper operation shall be provided under Section 16415 ELECTRICAL WORK, INTERIOR. Flexible connections between doors and fixed supports shall be made with extra flexible Type SJO cable, except in hazardous locations where wiring shall conform to NFPA 70, as appropriate. The cable shall have a spring-loaded automatic take up reel or a coil cord equivalent device.

2.1.10 Locking

Locking shall consist of [interior slide bolts, suitable for padlock by others, for manual push-up doors] [chain lock keeper, suitable for padlock by others, for chain operated doors]. Locking for motor operated doors shall consist of self-locking gearing [and optional master keyed cylinder with electrical interlock] [with chain lock for emergency hand chain].

2.1.11 Finish

****

NOTE: G60 galvanized coating with baked on primer coat and baked on finish coat should be suitable for most applications. There is no advantage to using heavier galvanizing under precoated primer systems; G90 galvanized coating and field painting is not needed, nor readily available from manufacturers.

****

2.1.11.1 Aluminum

Finishes shall be [clear anodized finish [AA-M10C22A31] [AA-M10C22A41]] [color anodized finish [AA-M10C22A32] [AA-M10C22A42]][the manufacturer's standard enamel finish] in accordance with the requirements of NAAMM AMP 501.

2.1.11.2 Steel

Steel surfaces shall be hot-dip galvanized G60 in accordance with ASTM A 653/A 653M, and shall be treated for paint adhesion and shall receive a [baked on prime coat and a baked on finish coat. The paint system shall withstand a minimum of 1500 hours salt spray test in accordance with ASTM B 117 without blistering, bubbling, or rust.] [baked on prime coat for field finishing. Finish coat shall be in accordance with Section09900PAINTING, GENERAL.]

2.1.11.3 Wood

Wood members shall receive a water-repellent treatment in accordance with NWWDA I.S. 4. Wood and hardboard surfaces shall be given a prime coat of paint at the factory.

2.1.12 Color

Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [white] [brown] [_____].

PART 3 EXECUTION

3.1 INSTALLATION

Doors shall be installed in accordance with approved detail drawings and manufacturer's instructions. Anchors and inserts for guides, brackets, [motors,] [switches,] hardware, and other accessories shall be accurately located. Upon completion, doors shall be free from warp, twist, or distortion. Doors shall be lubricated, properly adjusted, and demonstrated to operate freely. Aluminum materials that will be in contact with wet or pressure treated wood, mortar, masonry or ferrous metals shall be protected against galvanic or corrosive action. Doors to receive field finishing shall be finished in accordance with Section 09900 PAINTING, GENERAL. Caulking and sealants shall be in accordance with Section 07900 JOINT SEALING.

-- End of Section --

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DEPARTMENT OF THE ARMY — **CEGS-08390 (November 1997)**
U.S. ARMY CORPS OF ENGINEERS — **---------------------------**
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SECTION 13977

BLAST RESISTANT DOORS
11/97

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NOTE: This guide specification covers the requirements for manually operated swinging structural steel, reinforced concrete, and hollow metal blast resistant doors. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 318/318R	(1995) Building Code Requirements for Structural Concrete and Commentary
ACI 318M	(1995) Metric Building Code Requirements for Structural Concrete and Commentary

AMERICAN BEARING MANUFACTURERS ASSOCIATION (AFBEMA

AFBEMA Std 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
AFBEMA Std 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC ASD Mnl	(1989) Manual of Steel Construction Allowable Stress Design
AISC ASD Spec	(1989) Specification for Structural Steel Buildings - Allowable Stress Design, Plastic Design
AISC LFRD Vol I	(1995) Manual of Steel Construction Load & Resistance Factor Design, Vol 1: Structural Members, Specifications & Codes
AISC LFRD Vol II	(1995) Manual of Steel Construction Load & Resistance Factor Design, Vol II: Structural Members, Specifications & Codes

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI Cold-Formed Spec	(1996) Specification & Commentary for the Design of Cold-Formed Steel Structural Members (Part V of the Cold-Formed Steel Design Manual)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 242/A 242M	(1993a) High-Strength Low-Alloy Structural Steel
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM A 354	(1997) Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
ASTM A 366/A 366M	(1996) Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
ASTM A 449	(1993) Quenched and Tempered Steel Bolts and Studs
ASTM A 490	(1997) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
ASTM A 500	(1996) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 501	(1996) Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 514/A 514M	(1994a) High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A 529/A 529M	(1996) High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A 534	(1994) Carburizing Steels for Anti-Friction Bearings
ASTM A 563	(1996) Carbon and Alloy Steel Nuts
ASTM A 570/A 570M	(1996) Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM A 572/A 572M	(1997) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 574	(1997a) Alloy Steel Socket-Head Cap Screws
ASTM A 574M	(1997a) Alloy Steel Socket-Head Cap Screws (Metric)
ASTM A 588/A 588M	(1997) High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 in. (100 mm) Thick
ASTM A 606	(1997) Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A 607	(1996) Steel, Sheet and Strip, High-Strength, Low-Alloy, Columbium or Vanadium, or Both, Hot-Rolled and Cold-Rolled
ASTM A 611	(1997) Structural Steel (SS), Sheet,

	Carbon, Cold-Rolled
ASTM A 615/A 615M	(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 618	(1996) Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
ASTM A 653/A 653M	(1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 687	(1993) High-Strength Nonheaded Steel Bolts and Studs
ASTM A 706/A 706M	(1996b) Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 715	(1996) Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled, and Steel Sheet, Cold-Rolled, High-Strength, Low-Alloy, with Improved Formability
ASTM A 780	(1993a) Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A 792/A 792M	(1997) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM E 90	(1997) Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM F 436	(1993) Hardened Steel Washers
ASTM F 436M	(1993) Hardened Steel Washers (Metric)
ASTM F 568M	(1996) Carbon and Alloy Steel Externally Threaded Metric Fasteners
ASTM F 835	(1998) Alloy Steel Socket Button and Flat Countersunk Head Cap Screws
ASTM F 883	(1997) Padlocks

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1993) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A5.4	(1992) Stainless Steel Electrodes for Shielded Metal Arc Welding

AWS D1.1	(1996) Structural Welding Code - Steel
AWS D1.3	(1989) Structural Welding Code - Sheet Steel
AWS D1.4	(1992) Structural Welding Code - Reinforcing Steel

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A156.3	(1994) Exit Devices
BHMA A156.4	(1992) Door Controls - Closers
BHMA A156.8	(1994) Door Controls - Overhead Stops and Holders
BHMA A156.13	(1994) Mortise Locks & Latches
BHMA A156.20	(1996) Strap and Tee Hinges and Hasps

MILITARY SPECIFICATIONS (MS)

MS MIL-H-29181	(Rev B) Hasp, High Security, Shrouded, for High and Medium Security Padlock
MS MIL-H-43905	(Rev C) Hasps, High Security Padlocks
MS MIL-P-43607	(Rev G; Am 4) Padlock, Key Operated, High Security, Shrouded Shackle

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1995) Fire Doors and Fire Windows
NFPA 80A	(1996) Protection of Buildings from Exterior Fire Exposures
NFPA 101	(1997; Errata 97-1; ISA-97-1) Life Safety Code
NFPA 252	(1995) Fire Tests of Door Assemblies

1.2 DESCRIPTION

****

NOTE: Unlike most other doors, a blast door is provided by one manufacturer as a complete assembly including the door, frame, hardware, and accessories. This must be done because items such as the door, frame, latches, and hinges are of special manufacture and are interdependent parts of blast resistance. To facilitate the specification of individual door assemblies, the door type, blast effects, rebound, deformation limits, operating forces, hardware, and accessories for each door are brought together under a blast door assembly specification in Part 2 where assembly specification

paragraphs for the various door types are provided.

The designer will become familiar with these assembly paragraphs prior to specification editing. Coordinate with paragraph BLAST DOOR ASSEMBLIES.

****

[Structural steel doors shall be [flush mounted in frames] [or] [surface mounted] [as indicated].] [Reinforced concrete doors shall be surface mounted.] [Hollow metal doors shall be flush mounted in frames.] Doors shall be the manually operated, side hinged, swinging type. Each door assembly shall include the door, frame, anchors, hardware, and accessories and shall be provided by a single manufacturer. Frames and anchors shall be capable of transferring blast and rebound reactions to the adjacent supporting structure. Resistance to blast shall be demonstrated either by design calculations or tests on prototype door assemblies.

1.2.1 Design Requirements

1.2.1.1 Static Material Strength

The static values for minimum yield strength (or yield point) and (ultimate) tensile strength for steel shall be obtained from the applicable material specification. For tensile strength specified in terms of a tensile strength range, the lowest tensile strength specified shall be selected for design. Structural steel having a minimum static yield strength (or yield point) less than 50 ksi [and Grade 60 reinforcing bars] shall be designed using an average yield strength computed as 1.1 times the minimum static yield strength or yield point. If the minimum static yield for structural steel exceeds 345 MPa (50 ksi), the expected yield strength used for design shall be equal to the minimum specified static yield strength or yield point without increase. [The in-place compressive strength of concrete used for design shall be computed by multiplying the specified compressive strength by 1.1 to reach the expected compressed strength and then multiplying by not more than 1.15 to account for a one year age effect.] [The expected yield stress for steel sheet and strip used in design shall be computed as 1.21 times the specified static yield point.]

1.2.1.2 Dynamic Material Strength

The dynamic material strength shall be computed by applying a dynamic increase factor that accounts for the increase in material strength due to strain rate effects. The dynamic increase factor for structural steel in flexure shall be applied to the average yield strength and shall be [1.29] [_____], [1.19] [_____], and [1.09] [_____] for structural steel having a minimum yield strength (or yield point) of 36, 50, and 100 ksi, respectively. The dynamic increase factor for structural steel having a minimum yield strength (or yield point) between these values shall be obtained by interpolation. Optionally, for structural steel in these yield ranges, the dynamic increase factor shall be determined by a detailed analysis that accounts for the time to yield. The dynamic increase factor for structural steel having a minimum yield exceeding 100 ksi shall be 1.0. [The dynamic increase factor for Grade 60 flexural reinforcing bars shall be [1.17] [_____] applied to the average yield strength. The dynamic increase factor for concrete used in flexure shall be [1.19] [_____] applied to the in-place compressive strength. Optionally, the dynamic increase factor applied to flexural reinforcing bar yield and concrete compressive strength shall be determined by a detailed analysis that accounts for the time to steel yield and time to ultimate concrete strength.] [The dynamic increase factor for steel sheet and strip used in flexure shall be 1.1 applied to the average yield stress.]

1.2.1.3   Structural Member Design

[Structural steel section properties for rolled shapes shall be obtained from AISC LFRD Vol I, AISC ASD Mnl, or steel manufacturers' catalogs. The plastic moment capacity for single plate sections and sections built up from plates and shapes shall be computed as the average of the elastic and plastic section modulus multiplied by the dynamic yield strength, unless otherwise approved. Shear, welds, local buckling, and web crippling of structural steel shall be designed in accordance with AISC LFRD Vol II, the plastic design provisions of AISC ASD Spec, or by other approved methods except that for blast design, the load factors and resistance factors shall be equal to 1.0 and the dynamic yield strength shall be substituted for the static yield stress.] [Nominal reinforcing bar designations, weights, and dimensions shall be obtained from ACI 318/318R or the reinforcing bar specification. The moment of inertia of the reinforced concrete cross section used to determine the elastic deflection shall be the average of the moment of inertia of the gross section and the moment of inertia of the cracked section. The resistance of the reinforced concrete section shall be computed in accordance with ACI 318/318R or other approved methods except that for blast design, the load and resistance factors shall be equal to 1.0 and the dynamic reinforcing bar yield strength and dynamic ultimate concrete strength shall be substituted for the static strength values.] [Hollow metal doors shall be designed in accordance with AISI Cold-Formed Spec except that for blast design, the dynamic yield strength shall be substituted for the static yield point.]

1.2.1.4   Dynamic Analysis and Deformation

The door shall be designed using an equivalent single degree of freedom or other approved dynamic analysis method. The maximum door deformation shall be selected by the door manufacturer except that the maximum deformation in flexure shall not exceed the deformation limits specified or indicated. The deformation of structural steel members having a minimum yield strength or yield point greater than 65 ksi shall not exceed the elastic deflection. [Increased resistance due to strain hardening of structural steel in flexure can be used when the ductility ratio exceeds 10 or when otherwise approved.] [The ductility ratio for flexural members in hollow metal doors shall not exceed 1.0.]

1.2.1.5   Rebound Resistance

****

NOTE: For structural steel and hollow metal doors, specify 100 percent rebound resistance in the extreme case when the blast overpressure duration is much shorter than the expected period of the door and when rebound resistance must be guaranteed. Specify less than 50 percent rebound resistance in the extreme case when the blast overpressure duration is much longer than the expected period of the door. Specify zero rebound in the extreme case in which the door need not remain in place after the blast. Otherwise, specify 50 percent rebound resistance as recommended in TM 5-1300, Chapter 5. The most prevalent rebound resistance for reinforced

concrete doors is 20 and 100 percent.

Rebound for each door will be specified in paragraph BLAST DOOR ASSEMBLIES.
****

Rebound resistance shall be the specified or indicated percentage of the door resistance at initial peak response.

1.2.2 Blast Effects

****

NOTE: Specifying doors in terms of overpressure without duration is recommended only when the overpressure is low and the overpressure duration is greater than about 10 times the expected period of the door. Overpressure without duration is often specified for hollow metal doors because they have low overpressure resistance. Hollow metal doors are available to resist overpressures in the range from 6 to 173 kPa (1 to 25 psi), but a structural steel door option should be considered when the overpressure exceeds 83 kPa (12 psi).

Specifying time dependent overpressure is required for other than low and long duration overpressures and is recommended for reinforced concrete doors. When the waveform is other than a zero rise time triangle, show the waveform on the drawings.
****

1.2.2.1 Overpressure

The spatial distribution of overpressure shall be uniform unless otherwise specified or indicated. [For overpressure specified or indicated without duration, the overpressure waveform shall have a zero rise time and infinite duration.] [For overpressure specified or indicated with duration only, the waveform shall be a triangle with a zero rise time.] [Special waveforms are indicated.]

1.2.2.2 Overpressure Direction

[For overpressure identified as seating and for overpressure directions not otherwise specified or indicated, the positive phase overpressure shall be in the direction that causes the door to seat toward the frame.] [For overpressure identified as unseating, the positive phase overpressure shall be in the direction that causes the door to unseat away from the frame.]

1.2.2.3 Fragment Resistance

****

NOTE: Fragment design parameters will be determined in accordance with TM 5-1300, chapter 2 and TM 5-855-1 as applicable. Exposing blast doors to primary fragments is not recommended because of the resulting severe damage to hardware, because molten

fragments can weld the door to the frame preventing post-blast opening, and because it is difficult to prevent perforation at the door edges. Also, while latches and latch mechanisms can be protected, it is usually not practical to protect the hinges.

Worst-case fragment perforation of the door can be prevented for structural steel and reinforced concrete doors by specifying fragment characteristics or a minimum plate or concrete thickness in the door assembly paragraph.

The 100 and 200 mm (4 and 8 inch) reinforced concrete nominal thickness shown are typically available.

Hollow metal doors cannot prevent perforation by primary fragments and will not be used for this purpose.

Fragment parameters or door thickness will be specified in paragraph BLAST DOOR ASSEMBLIES.

****

For doors specified or indicated to resist fragments, the door and the door and frame interface shall be designed to prevent fragment perforation and the latches and latching mechanism shall be shielded from fragment damage. The fragment impact point shall be anywhere on the door and frame face exposed to overpressure.

1.2.3 Blast Door Operation

****

NOTE: Specify swing forces of 90 and 70 N (20 and 15 pounds) for hollow metal doors, 135 and 90 N (30 and 20 pounds) for structural steel doors, and 180 and 90 N (40 and 20 pounds) for 200 mm (8 inch) thick reinforced concrete doors and heavy structural steel doors. Use the lower values for structural and hollow metal doors when rolling bearing hinges are specified.

For latch engagement and release, specify 90 to 135 N (20 to 30 pounds) for structural steel doors without gasket seals and for reinforced concrete doors. Specify 135 to 180 N (30 to 40 pounds) for structural steel doors with gasket seals is recommended to accommodate the extra force required to compress the gasket during latching.

For means of egress, specify NFPA 101 operating forces. In this case, Type I (rolling bearing) hinges are recommended.

Operating requirements will be specified in

paragraph BLAST DOOR ASSEMBLIES.
****

The force required to set the door in motion shall be measured from the 90-degree open position, and the force required to engage and release the latches shall be measured at the latch handle with the door in the normal closed position.

1.3 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Blast Resistant Door; GA.

Data on standard blast doors consisting of catalog cuts, brochures, circulars, specifications, and product data that show complete dimensions and completely describe overpressure ratings, rebound ratings, doors, frames, anchors, hardware, and accessories.

Contractor Design Calculations; GA.

Detailed structural analysis and design calculations demonstrating resistance to blast when blast resistance is not demonstrated by prototype tests. Design calculations shall demonstrate adequacy under the blast effects specified or indicated. Design calculations shall include a sketch of the overpressure waveform; dimensioned sketches of blast resisting elements such as door members, frame members, latches, and hinges; section properties for blast resisting members including built-up sections; the standard under which steel is produced; static and dynamic material strength properties; the resistance, stiffness, mass, elastic natural period, and elastic deflection for flexural members; and the peak deflection, peak support rotation, and time to peak deflection for door members in flexure. Design calculations shall cover initial response, rebound, and all secondary items such as shear, welds, local buckling, web crippling, hinges, and latches.

Test on Prototype Door; GA.

Certified test reports demonstrating blast resistance. Test reports shall include the name and location of the testing agency or laboratory, a description of the testing apparatus, the date of the tests, a description of the door specimen tested, descriptions of loadings, and the value of measured peak door deflection and peak permanent set. Test reports shall include analysis and interpretation of test results.

SD-04 Drawings

Contractor Design of Blast Resistant Doors; GA.

For special doors or standard doors with appreciable modifications, detailed fabrication and assembly drawings indicating the door location and showing dimensions, materials, fabrication methods, hardware, and accessories in sufficient detail to enable the Contracting Officer to check compliance with contract documents. Weld symbols used shall conform to AWS A2.4. These drawings need not be submitted for standard doors for which manufacturer's catalog data is submitted.

SD-06 Instructions

Blast Resistant Door; FIO.

Manufacturer's instructions for installation and field testing.

SD-08 Statements

Manufacturer's Field Service; FIO.

Information describing training to be provided, training aids to be used, and background data on the personnel conducting the training.

SD-09 Reports

Blast Door Shop and Field Operating Tests; GA.

Shop and field operating test reports that include values for opening and closing forces and times, forces required to operate latches, and a description of all operating tests performed.

Fire Rated Blast Door; GA.

In lieu of a UL listing for fire door assemblies, a letter may be submitted by the testing laboratory which identifies the submitted product by manufacturer and type or model and certifies that it has tested a sample assembly and issued a current listing.

SD-13 Certificates

Certificates of Compliance; GA.

Steel mill reports covering the number, chemical composition, and tension properties for structural quality steels. When blast resistance is demonstrated by calculations, a certificate stating that the door assembly provided was manufactured using the same materials, dimensions, and tolerances shown in the calculations. When blast resistance is demonstrated by prototype testing, a certificate stating that door and frame provided was manufactured using the same materials, dimensions, and tolerances as the tested prototype and listing the hardware and frame anchors required to achieve blast resistance. Each certificate shall be signed by an official authorized to certify in behalf of the manufacturer and shall identify the door assembly and date of shipment or delivery to which the certificate applies.

Fire Rated Blast Door; GA.

Certificate of inspection conforming to NFPA 80, NFPA 80A, and NFPA 101 for fire doors exceeding the size for which label service is available.

Thermal Insulated Blast Door; GA.

Sound Rated Blast Door; GA.

Certification or test report for [thermal insulated] [sound rated] doors listing the type of hardware used to achieve the rating.

SD-19 Operation and Maintenance Manuals

Blast Resistant Door; FIO.

Information bound in manual form consisting of manufacturer's safety precautions, preventative maintenance and schedules, troubleshooting procedures, special tools, parts list, and spare parts data. All material shall be cross referenced to the door designations shown on the drawings.

1.4   QUALIFICATIONS

****

NOTE: Delete AWS D1.3 requirement when hollow metal doors are not specified. Delete AWS D1.4 requirement when reinforced concrete doors are not specified.

****

Welders, welding operators, and weld inspectors shall be qualified in accordance with AWS D1.1 [except that] [welders performing arc welding of steel sheet and strip shall be qualified in accordance with AWS D1.3] [and] [welders and weld operators performing welding of reinforcing bars shall be qualified in accordance with AWS D1.4].

1.5   DELIVERY AND STORAGE

Door assemblies delivered and placed in storage shall be stored with protection from weather and dirt, dust, and contaminants.

1.6   WARRANTY

Manufacturer's written warranty covering the blast door assembly for 2 years after acceptance by the Government shall be furnished. Warranty shall provide for repair and replacement of the blast door assembly and individual hardware and accessory items in the event of malfunction due to defects in design, materials, and workmanship except that the warranty need not cover finishes provided by others.

PART 2   PRODUCTS

2.1   MATERIALS

Only structural quality steel materials for which tension properties have been obtained shall be used to resist blast except that commercial quality steel sheet and strip shall be permitted for prototype tested hollow metal doors. Steel used in the door, door frame, and door frame anchors and non stainless steel fasteners that resist blast shall be selected from the materials specified.

2.1.1 Concrete and Concrete Reinforcement

****

NOTE: Retain this paragraph when reinforced concrete doors are specified.

****

Concrete is specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete reinforcement shall conform to ASTM A 615/A 615M or ASTM A 706/A 706M, Grade 60.

2.1.2 Structural Tubing

****

NOTE: Retain this paragraph when structural steel or hollow metal doors are specified.

****

Structural tubing shall conform to ASTM A 500, ASTM A 501, or ASTM A 618.

2.1.3 Structural Steel

****

NOTE: For reinforced concrete and hollow metal doors, specify only ASTM A 36/A 36M.

****

Structural steel bars, plates, and shapes shall conform to ASTM A 36/A 36M, ASTM A 242/A 242M, ASTM A 529/A 529M, ASTM A 572/A 572M, or ASTM A 588/A 588M. Quenched and tempered steel plate shall conform to ASTM A 514/A 514M.

2.1.4 Steel Sheet and Strip

****

NOTE: Retain this paragraph when hollow metal doors are specified.

****

Steel sheet and strip shall conform to ASTM A 366/A 366M; ASTM A 653/A 653M, Grades A, B, C, D, and F; ASTM A 653/A 653M; ASTM A 570/A 570M; ASTM A 606; ASTM A 607; ASTM A 611, Grades A, B, C, and D; , ASTM A 715 Grades 50 and 60; or ASTM A 792/A 792M, Grades 33, 37, 40, and 50.

2.1.5 Fasteners

Steel studs and bolts shall conform to ASTM A 307, ASTM A 325, ASTM A 354, ASTM A 449, ASTM A 490, or ASTM A 687 as applicable. Steel nuts shall conform to ASTM A 563. Hardened circular, beveled, and clipped washers shall conform to ASTM F 436. Steel hex cap screws shall conform to ASTM F 568M. Steel socket-headed cap screws shall conform to ASTM A 574. Steel button and flat-headed countersunk cap screws shall conform to ASTM F 835.

2.2 HARDWARE

2.2.1 Hinges

****
NOTE: Retain rolling bearing and operating cycle description under General Requirements when hinge Type 1 is specified.

Blast door hinges are normally full surface. Mortise hinges can be specified for hollow metal doors, but availability must be verified with door manufacturers.

Hinge Type 1 is intended for cases where high usage with smooth operation is the main requirement and is generally appropriate for facilities designed to resist the effects of improvised explosive devices.

Hinge Type 2 is intended for cases where in-structure shock could damage rolling thrust bearings and is recommended for facilities designed to resist the effects of conventional weapons.

Hinge Type 3 is recommended for low use applications such as infrequently used access doors.
****

2.2.1.1 General Requirements

Hinges shall be specially manufactured to support the door and to resist blast induced loading. The number of hinges shall be determined by the blast door manufacturer. Welds used in hinges shall be continuous. Hinges shall be attached to the door and frame using mechanical fasteners except that full surface hinges for doors with locks shall be attached to the door and frame by welding or approved tamper-resistant mechanical fasteners and hinges for doors with locks shall have approved nonremovable pins. Load ratings and fatigue life for ball and roller bearings shall be determined in accordance with AFBEMA Std 9 and AFBEMA Std 11 as applicable and, unless otherwise approved, the bearing steel shall conform to ASTM A 534. Hinges shall be capable of operating for the minimum number of cycles specified without failure or excessive wear under the door service loads where one cycle consists of swinging the door back and forth between the normal closed position and the 90-degree open position, where failure or excessive wear means that the latches do not seat properly or the door does not swing smoothly due to hinge failure or wear, and where door service loads consist of the door weight plus any loads produced by hardware. Rolling bearings shall be factory grease lubricated and either sealed or provided with easily accessible lubrication fittings.

2.2.1.1 Hinge Description

[Hinge Type 1 shall be capable of smooth operation for a minimum of 250,000 cycles. This type of hinge shall be provided with structural quality steel pins and leafs and either rolling bearings in both the thrust and radial directions or hardened steel washer (disc) thrust bearings and rolling radial bearings except that rolling thrust bearings and metallic journal radial bearings shall be permitted for hollow metal doors when the specified overpressure is less than 3 psi.] [Hinge Type 2 shall be smooth operating and shall be provided with structural quality steel pins and leafs, steel base washer (disc) thrust bearings, and metallic journal radial bearings or other approved non rolling type bearings.] [Hinge Type 3 shall be provided with metallic bearings.]

2.2.2 Latching System

2.2.2.1 Latching Points

The number of latching points shall be determined by the door manufacturer. [For multiple latching points, latching points can be provided at the head, sill, and jambs.] [For jamb latching points, latching points shall be provided at the jambs only.]

2.2.2.2 Latching System Operation

****

NOTE: Retain the first sentence when hinge Type 1 is specified.

****

Latching systems shall be capable of operating for the same number of cycles specified for the door hinges where one latch operating cycle consists of engaging and releasing using the handle. Latches shall remain engaged until manually released and shall not release under blast loads or rebound. [Manually operated latches shall remain in the released position until manually engaged.] [Self-latching latches shall provide self-activating engagement when the door is swung to the normal closed position.] Handles shall release latches under a clockwise motion.

2.2.2.3 Latching Mechanism

[Latching mechanisms and latches for structural steel doors shall be mounted on the seating face of the door.] [Latching mechanisms for hollow metal doors shall be mounted on the seating face of the door and safety covered.] [Unless otherwise approved, latch handle axles (spindles) for [structural steel doors] [and] [reinforced concrete doors] shall extend through the blast load carrying portion of the door and shall be provided with suitable metallic journal bearings.] Latch handle axles shall be manufactured of hardened steel or stainless steel, and axles requiring lubrication shall be provided with easily accessible lubrication fittings.

2.2.2.4 Safety Cover

****

NOTE: Safety covers apply to structural steel and hollow metal doors.

****

Safety covers shall consist of steel housings that enclose the latching mechanism such that only the operating rods are exposed.

2.2.2.5 Cover Plate

Cover plates for structural steel doors shall be manufactured of minimum 1/4 inch thick plate and shall enclose the entire latching mechanism.

2.2.2.6 Latches

****
NOTE: Retain lever type latches for reinforced concrete doors.
****

Latches (latch bolts) shall be manufactured of structural quality steel and the latch bolt throw shall not be less than 3/4 inch. Latch bolts shall be the sliding type in which the latch bolt slides into a matching strike in the door frame [or the lever type in which the latch bolt rotates into a groove in the frame as specified or indicated] [except that latches for doors with [mortise lock and latch sets] [and] [exit devices] shall be the sliding type]. Manually operated latches shall draw the door toward the frame during latching.

2.2.2.7 Handle

****
NOTE: Wheel or spoke handle options are recommended for structural steel doors when gasket seals are specified.
****

[Handles for doors without locks shall be manufactured of steel castings, forgings, pipe, round tubing, bar, or plate and shall be one piece or have welded joints except that wheel handles can be manufactured of aluminum castings.] [Handles for doors with mortise lock and latch sets shall be manufactured of [steel castings] [or] [stainless steel].] Latch handles shall be firmly fastened to axles. Lever handles shall be perpendicular to the door edge when latches are engaged. [Single lever handles shall be located at the stile opposite the hinges.] [[Wheel] [and spoke lever] [Spoke lever] handles shall be located approximately halfway between the stiles.]

2.2.3 Mortise Lock and Latch Set

****
NOTE: Mortise lock and latch sets are practical only for hollow metal doors. These lock and latch sets are special built and are not normally cycle tested as specified in BHMA A156.13. Mortise lock and latch sets are usually specified only when a deadbolt function is required.
****

Lever handles shall release latches using a torque not exceeding 27 lb-in. Latches (latch bolts) shall be located at the stiles and operated from a single lever handle. Only one deadbolt shall be provided. The deadbolt shall be manufactured of structural quality steel and the deadbolt throw shall not be less than 1 inch. Mortise locks shall be provided with armored fronts. The function numbers for mortise locks shall be as defined in BHMA A156.13.

2.2.4 Keying

[Keying shall conform to Section 08700 BUILDERS' HARDWARE.] [Change keys for locks shall be stamped with change number and the inscription "U.S.

Property - Do Not Duplicate." Unless otherwise specified, two change keys shall be provided for each lock.] [Locks shall be furnished with the manufacturer's standard construction key system.]

2.2.5   Exit Device

****

NOTE: Exit devices are practical only for hollow metal doors and light structural steel doors.

****

Latches (latch bolts) shall release by depressing the actuation bar using a force of not more than 15 pounds applied perpendicular to the door in the swing direction. The exit device shall [conform to the finish test values specified in BHMA A156.3 and shall be of] [stainless steel construction][and] plain design with straight, beveled, or smoothly rounded sides, corners, and edges. A touch bar may be provided in lieu of a conventional actuation bar (cross bar). The function numbers for exit devices shall be as defined in BHMA A156.3.

2.2.6   Straight Steel Bar Door Pull

****

NOTE: This door pull is intended for structural steel and reinforced concrete doors. Type III normally applies.

****

Straight steel bar door pulls shall be manufactured of round steel bar. The type furnished shall be [Type I: 1/2 inch diameter, 5 inch grip and 2-1/2 inch projection with 1/2 inch inside bend radiuses] [;] [and] [Type II: 5/8 inch diameter, 12 inch grip and 4 inch projection with 15/16 inch inside bend radiuses] [; and] [Type III: 5/8 inch diameter, 8 inch grip and 4 inch projection with 15/16 inch inside bend radiuses]. Grip and projection dimensions are measured from the bar centerline. The pull shall be attached to the door by fillet welding all around.

2.2.7   Padlock

****

NOTE: For ASTM F 883 padlock, specify Type P01 (key operated) or P02 (combination operated) and Grade 1 (lowest) to 6 (highest) performance. Available ASTM F 883 options are "A" (key is captive in cylinder when padlock is unlocked), "B" (removable cylinder), "C" (changeable combination), "D" (combination operated with key control), "E" (corrosion resistant), and "F" (provided with nonferrous shackles).

****

Low security padlocks shall conform to ASTM F 883, Type [PO1] [PO2], Option [_____] [and] [_____], Grade [_____].

2.2.8   Shrouded Padlock

****

NOTE: Use a shrouded padlock in conjunction with a hasp conforming to MS MIL-H-29181 or MS MIL-H-43905.
****

High security padlocks with shrouded shackles shall conform to MS MIL-P-43607.

2.2.9 Hasp

Low security hasps shall conform to BHMA A156.20, Grade [1] [2] [3], steel, [safety] [or] [open hinge] type with [adjustable] [,] [or] [swivel] [,] [or] [fixed] staple, [paint finished] [or] [galvanized] [as specified] and screw fastened to the door and frame.

2.2.10 High Security Hasp

****
NOTE: This high security hasp is a non-shrouded mortise type. Styles 1 through 9 are available. Consult referenced military specification.
****

High security hasps shall conform to MS MIL-H-43905, Style [_____] [carbon] [corrosion resistant] steel, attached by [fasteners] [welding].

2.2.11 Shrouded Hasp

****
NOTE: Style 1 applies to right-hand doors and Style 2 to left-hand doors.
****

High security shrouded hasps shall conform to MS MIL-H-29181, Style [1] [or] [2] [as applicable].

2.2.12 Door Stop

Door stops shall be designed to resist the impact of the door. The stop shall not scratch or scar the door finish when the door is opened against the stop.

2.2.13 Surface Door Closer

****
NOTE: Door closers are practical only for hollow metal doors and light structural steel doors.
****

The surface door closer shall conform to BHMA A156.4. The size and grade shall be selected by the door manufacturer.

2.2.14 Overhead Door Holder

Overhead door holder shall be surface mounted. The holder shall have a spring or other device to cushion the door action and shall limit the door swing at [85] [110] degrees. [The holder shall have a built-in, hold-open capability at the swing limit specified.] [Overhead door holders for hollow metal doors weighing less than 200 pounds shall conform to BHMA A156.8.]

2.2.15 Gasket Seal

****
NOTE: Gasket seals are recommended for reinforced concrete doors.

Gasket seals installed in manually operated doors are not recommended for reliable prevention of blast leakage. Seals are typically used for reinforced concrete doors to improve the weather seal and provide a door silencer.
****

Sealed doors shall have the full door perimeter and all door penetrations sealed. Perimeter seals shall be the rubber gasket type. Gaskets shall be removable, capable of sealing the mating surfaces, and resistant to the atmospheric environment. One spare set of gasket seals shall be provided for each door assembly for which gasket seals are specified.

2.2.16 Door Silencer

****
NOTE: When gasket door seals are specified, the gasket seal will act as the silencer.
****

Rubber door silencers shall cushion the impact of the door against the frame so that steel-to-steel contact is not made during closing.

2.2.17 Optical Device

The optical device (spy hole) shall be wide angle and shall not be breeched or dislodged by the specified or indicated blast overpressure. The device shall permit observation from the seating face of the door and shall be located approximately 5 feet above the seating side floor and approximately centered between the stiles.

2.3 ACCESSORIES

2.3.1 Subframe

At the Contractor's option, a subframe can be provided and built into the structure prior to installation of the frame. The subframe and subframe anchors shall be capable of transferring blast and rebound reactions to the adjacent structure, and the frame shall be capable of transferring these reactions to the subframe. The subframe shall be fabricated in the same manner specified for the frame.

2.3.2 Nameplate

Each door assembly shall have a permanently affixed nameplate that displays the manufacturer's name, place and year of manufacture, and the applicable peak overpressure, impulse, and rebound rating.

2.3.3 Removable Threshold

The sill shall be flush with the adjacent floor when the threshold is removed. The removable threshold shall be attached using approved countersunk mechanical fasteners.

2.3.4   Ramp

The ramp shall be structural steel, portable, and weigh not more than [200] [_____] pounds. The ramp shall be of sufficient length to extend the full door opening width and shall have the profile indicated. The ramp shall be capable of supporting [a wheel load of [_____] pounds] [the wheel load indicated].

2.3.5   Self-Rescue Kit

****
NOTE: Self-rescue kits are usually specified only when post-blast operation is desired and debris could prevent the door from opening.
****

Self-rescue kits shall contain illustrated instructions, nonadjustable wrenches, screwdrivers, jacks, and all other tools required to open the blast door from the seating face to a width of at least 12 inches. The jack capacity shall not be less than [75,000] [_____] pounds. Tools shall be securely mounted in a steel frame using wing nuts or other approved fasteners. The self-rescue kit frame shall be fabricated in the same manner specified for the door frame and shall be securely anchored to the wall at the location indicated or as directed.

2.4   FABRICATION

2.4.1   Shop Assembly

****
NOTE: Delete welding of stainless steel when only reinforced concrete doors are specified.

For reinforced concrete doors, spall plates will be specified for all cases except in extreme cases where it is certain that spall damage is nonexistent or when faceplates are used.

Specify faceplates for exterior doors in conventional weapons resistant facilities in cases where construction is to parallel NATO criteria.

Composite faceplated reinforced concrete doors with studs welded to both faceplates are also available. When these doors are required, specify the following in the fabrication paragraph: "Composite faceplated reinforced concrete doors shall be provided with studs shop welded to faceplates at both ends of the stud.   Studs shall be of sufficient diameter and spacing to effectively transfer shear forces." Specify the following under door assembly paragraph Door Type: "Composite faceplated reinforced concrete door."
****

Welding shall be in accordance with AWS D1.1 except that arc welding of steel sheet and strip shall be in accordance with AWS D1.3 and welding of concrete reinforcing bars shall be in accordance with AWS D1.4. [Stainless steel shall be welded using electrodes conforming to AWS A5.4.] [Structural steel doors shall be of welded construction.] Fabricated steel shall be well-formed to shape and size, with sharp lines and angles. Intermediate and corner joints shall be coped or mitered. Exposed welds shall be dressed smooth. [The stiles [and top] of built-up structural steel doors shall be closed using channel shapes or plates.] [When feasible, faceplates for structural steel doors shall be one piece. When one-piece faceplates are not feasible, plates shall be joined using full penetration groove weld butt joints or other approved welds.] [Reinforced concrete doors shall be closed at the edges with structural steel channels or plates and latch housings shall be mortised. Lap splices shall not be used for flexural reinforcing bars.] [Spall plates shall be one piece, covering the entire concrete surface on the seating face of the door, and shall be securely welded to the door edges. Spall plates shall not be less than 1/4 inch thick.] [Faceplated reinforced concrete doors shall be provided with one-piece faceplates on both door faces. Faceplates shall cover the entire concrete surface and shall be securely welded at the door edges. Faceplates shall be not less than 3/8 inch thick.] [Hollow metal door frames shall be pressed steel or structural steel with welded joints. Steel frames or subframes installed in masonry walls shall be provided with adjustable anchors. Hollow metal doors shall be of unitized grid construction with welded grid junctions and shall have flat, one-piece face sheets spot welded to each face of the grid system. The edges of hollow metal doors shall be closed with seams continuously welded. Hollow metal doors shall be neat in appearance, free from warpage and buckle, and suitable reinforcing shall be provided for hardware.]

2.4.2 Mullion

Mullions for double doors shall be fabricated in the same manner specified for frames. [Fixed mullions shall be welded to the frame.] [Removable mullions shall be attached to the frame with mechanical fasteners that are accessible for mullion removal or, in lieu of the removable mullion, an astragal shall be provided at the seating face of the inactive door leaf.] Doors shall seat directly against the mullion, and the mullion or astragal shall be capable of transferring the door reactions to the frame.

2.4.3 Thermal Insulation

****

NOTE: Thermal insulation is practical only for hollow metal doors.

****

The interior cells between the unitized grid shall be completely filled with thermal insulation material. The U value through the door (panel) shall not exceed [0.24] [_____].

2.4.4 Shop Finishing

[Shop priming of steel surfaces shall conform to Section 09900PAINTING, GENERAL except that surfaces that will be embedded in concrete need not be primed and hollow metal doors shall be either dipped in primer after welding is completed, or exposed surfaces shall be primed and interior surfaces coated with an approved rust inhibitor]. [Galvanizing of doors and frames shall conform to ASTM A 123/A 123M or other approved methods. Surfaces that will be embedded in concrete need not be galvanized and the interior of hollow metal doors may be treated with an approved rust inhibitor in lieu of galvanizing. Galvanizing of exposed portions of concrete anchors, non stainless steel fasteners, and hardware other than factory finished hardware shall conform to ASTM A 153/A 153M or other approved methods.]

2.4.5 Clearance

[The clearance between the seated steel surfaces of structural steel doors and frames shall not exceed 1/16 inch.] [The lateral clearance between flush mounted structural steel doors and frames shall not exceed [1/4] [_____] inch at the head and jambs and the clearance between the meeting edges of pairs of doors shall not exceed [1/2] [_____] inch.] [The lateral clearance between hollow metal doors and frames shall not exceed 1/8 inch at the head and jambs and the clearance between the meeting edges of pairs of doors shall not exceed 1/4 inch.] The clearance between the door bottom and threshold shall not exceed 3/4 inch.

2.5 BLAST DOOR ASSEMBLIES

****

NOTE: The assembly paragraphs provided for structural steel, reinforced concrete, and hollow metal doors will be repeated and edited as many times as required to specify all door assemblies. The door designations will then be referenced in the door schedule on the drawings. Items shown on the drawings will not be duplicated in the door assembly paragraphs. The door assembly paragraphs are pre-edited to show normal use and hardware availability; e.g., thermal insulation, sound rating, and mortise locks are omitted for structural steel and reinforced concrete doors, Type 2 hinges are normally used for reinforced concrete doors and thus are shown without brackets, etc.

****

2.5.1 Door [_____]; Steel

****

NOTE: Coordinate with paragraphs DESCRIPTION and BLAST DOOR ASSEMBLIES.

****

2.5.1.1 Type

Type shall be [structural steel] [double structural steel door with [fixed] [or] [removable] mullion] [,] [galvanized] [,] [and] [fire-rated].

2.5.1.2 Overpressure

Overpressure shall be [_____] psi [with a [_____] millisecond duration] in the [seating] [unseating] direction [and [_____] psi [with a [_____] millisecond duration] in the unseating direction]. The [shock and gas overpressure] [overpressure] waveform shall be as indicated.

2.5.1.3   Fragment

****
NOTE: Coordinate with paragraph Fragment Resistance, under paragraph DESCRIPTION.
****

[The fragment shall be [_____] ounces with a velocity of [_____] fps and impact [normal to][at an angle of [_____] degrees measured from] the door face.] [Protection from fragments shall be provided by steel plate not less than [_____] inches in thickness.]

2.5.1.4   Rebound

****
NOTE: Coordinate with paragraph Rebound Resistance, under paragraph DESCRIPTION.
****

Rebound resistance shall be [50] [100] [_____] percent.

2.5.1.5   Deformation Limits

****
NOTE: For structural steel doors, the deformation limit criteria for accidental explosion applications is given below.

Prot. Cat. No.	**Support Rotation (Deg.)**	**Ductility Ratio**
1	**2**	**10**
2	**12**	**20**

A 2-degree support rotation and ductility ratio of 10 is recommended when post-blast opening is required. This deformation limit is recommended for conventional weapon and improvised weapon exterior door applications in order to avoid entrapment of personnel.
****

The ductility ratio shall not exceed [10 and the support rotation shall not exceed 2 degrees] [20 and the support rotation shall not exceed 12 degrees].

2.5.1.6   Hardware

****
NOTE: Coordinate with paragraph Hinges, under paragraph HARDWARE. A door pull is recommended.
****

Full surface hinges shall be Type [1] [2] [3]. [Multiple] [Jamb] latching points and [multiple lever handles] [,] [or] [a single lever handle] [,] [or] [a wheel handle] [,] [or] [a spoke lever handle] operated from [the seating face] [and] [opposite the seating face] with [manual] [self-latching] latch engagement and [either] sliding [or lever] latch bolts shall be provided. The latching mechanism shall be [safety] [or] [cover] plated. A [Type [I] [II] [III] straight steel bar door pull] [,] [and] [padlock] [shrouded padlock] [,] [and] [hasp] [high security hasp] [shrouded hasp] [,] [and] [door stop] [,] [and] [surface door closer] [overhead door holder] [,] [and] [gasket seals] [door silencer] [,] [and] [optical device] shall be provided.

2.5.1.7 Operating Forces

****
NOTE: Coordinate with paragraph Blast Door Operation, under paragraph DESCRIPTION.
****

[Maximum operating forces shall be [30] [40] [_____] pounds to set the door in motion and [20] [_____] pounds to swing the door. Maximum force to engage and release latches shall be [20] [30] [40] [_____] pounds.] [Operating forces shall conform to NFPA 101.]

2.5.1.8 Accessories

A [removable threshold] [or] [ramp] [and] [self-rescue kit] shall be provided.

2.5.2 Door [_____]; Concrete

****
NOTE: Coordinate with paragraph DESCRIPTION and paragraph BLAST DOOR ASSEMBLIES.
****

2.5.2.1 Type

Type shall be [reinforced concrete] [double reinforced concrete] door with [fixed] [or] [removable] [mullion] [and] [with] [spall plate] [faceplates].

2.5.2.2 Overpressure

Overpressure shall be [_____] psi [with a [_____] millisecond duration] in the [seating] [unseating] direction [and [_____] psi with a [_____] millisecond duration in the unseating direction]. The [shock and gas overpressure] [overpressure] waveform shall be as indicated.

2.5.2.3 Fragment

****
NOTE: Coordinate with paragraph Fragment Resistance, under paragraph DESCRIPTION.
****

[The fragment shall be [_____] ounces with a velocity of [_____] fps and impact [normal to][at an angle of [_____] degrees measured from] the door face.] [The nominal door thickness shall not be less than [4] [8] [_____] inches.]

2.5.2.4 Rebound

****

NOTE: Coordinate with paragraph Rebound Resistance, under paragraph DESCRIPTION.
****

Rebound resistance shall be [20] [100] [_____] percent.

2.5.2.5 Deformation Limits

****
NOTE: For reinforced concrete doors, the deformation limit criteria for accidental explosion applications is given below.

Door Type	Prot. Cat. No.	Support Rotation (Deg.)
One-way acting without stirrups	1 2	1 2
One-way acting with stirrups	1 2	2 4
Two-way acting	1 2	2 8

A support rotation of not more than 2 degrees is recommended when post-blast opening is required. This deformation limit is recommended for conventional weapon and improvised weapon exterior door applications in order to avoid entrapment of personnel.
****

[The door support rotation shall not exceed [1 degree] [2 degrees] for one-way acting doors without stirrups, [2] [4] degrees for one-way acting doors with stirrups, and [2] [8] degrees for two-way acting doors.] [The support rotation shall not exceed 2 degrees except that the support rotation for one-way acting doors without stirrups shall not exceed 1 degree.]

2.5.2.6 Hardware

Hinges shall be Type 2. [Multiple] [Jamb] latching points and multiple lever handles operated from [the seating face] [and] [opposite the seating face] with manual latch engagement and lever latch bolts shall be provided. Type [I] [II] [III] straight steel bar door pull [,] [and] [padlock] [shrouded padlock] [,] [and] [hasp] [high security hasp] [shrouded hasp] [,] [and] [door stop] [,] gasket seals [, and optical device] shall be provided.

2.5.2.7 Operating Forces

****
NOTE: Coordinate with paragraph Blast Door Operation, under paragraph DESCRIPTION.
****

Maximum operating forces shall be [40] [_____] pounds to set the door in motion and [20] [_____] pounds to swing the door. Maximum force to engage and release latches shall be [30] [_____] pounds.

2.5.2.8 Accessories

A [removable threshold] [ramp] [and] [self-rescue kit] shall be provided.

2.5.3 Door [_____]; Metal

****
NOTE: Coordinate with paragraph DESCRIPTION and with paragraph BLAST DOOR ASSEMBLIES.

The STC value bracketed is close to the highest obtainable for blast doors.
****

2.5.3.1 Type

Type shall be [hollow metal] [double hollow metal door with a [fixed] [or] [removable] mullion] [,] [galvanized] [;] [and] [thermal insulation] [sound-rated to STC [40] [_____]] [, and] [fire-rated].

2.5.3.2 Overpressure

Overpressure shall be [_____] psi in the [seating] [unseating] direction [and [_____] psi in the unseating direction].

2.5.3.3 Rebound

****
NOTE: Coordinate with paragraph Rebound Resistance, under paragraph DESCRIPTION.
****

Rebound resistance shall be [50] [100] [_____] percent.

2.5.3.4 Hardware

****
NOTE: Coordinate with paragraph Hinges, under paragraph HARDWARE.

Delete the latch sentence when a mortise lock and latch set or exit device is specified.
****

[Full surface] [Mortise] hinges shall be Type [1] [2] [3]. [[Multiple] [Jamb] latch points and [multiple lever handles] [or] [a single lever handle] operated from the [seating face] [and] [opposite the seating face] with [manual] [self-latching] latch engagement and [either] sliding [or lever] latch bolts shall be provided.] [Exit device with [multiple latch points] [jamb latch points] [and with function [_____]] shall be provided.] [Mortise lock and latch set [with function [_____]] shall be provided.] [A [padlock] [and] [hasp] [,] [and] [door stop] [,] [and] [surface door closer] [overhead door holder] [,] [and] [gasket seals] [door silencer] [,] [and] [optical device] shall be provided.]

2.5.3.5 Operating Forces

****

NOTE: Delete the latch operating force sentence when a mortise lock and latch set or exit device is specified.

Coordinate with paragraph Blast Door Operation, under paragraph DESCRIPTION.

****

[Maximum operating forces shall be [20] [_____] pounds to set the door in motion and [15] [_____] pounds to swing the door.] [Operating forces shall conform to NFPA 101.] Maximum force shall be [20] [_____] pounds to engage and release latches.

2.5.3.6 Accessories

A [removable threshold] [or] [ramp] shall be provided.

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

2.6.1 Prototype Static Test

****

NOTE: Retain this paragraph when overpressure is specified without duration.

****

Static tests on prototype door assemblies shall demonstrate that the door will resist the blast overpressure. Static tests will be accepted only if the door and frame proposed are manufactured using the same materials, dimensions, and tolerances as those in the prototype static test and the static overpressure used in the test is at least two times the blast overpressure. Static test reports shall be supplemented with calculations that demonstrate rebound resistance when rebound is not tested.

2.6.2 Prototype Blast Test

Blast tests on the prototype door assembly shall demonstrate that the door will resist the overpressure waveform. Blast tests will be accepted only if the door and frame proposed are manufactured using the same materials, dimensions, and tolerances as those in the prototype blast tests. The rise time of the test waveform shall be zero or subject to approval. [For an overpressure with infinite duration, the overpressure used in the test shall be not less than that specified or indicated for a duration equal to at least five times the natural period of the door and the test report shall be supplemented with calculations that demonstrate the specified or indicated rebound resistance.] [For overpressure with finite duration, the overpressure waveform used in the test shall exceed the overpressure waveform in both peak overpressure and impulse and the blast test report shall be supplemented with calculations that demonstrate the specified or indicated rebound resistance when the positive phase waveform duration in the test exceeds the positive phase duration specified or indicated.]

2.6.3 Shop Operating Test

Prior to shipment, each door assembly shall be fully erected in a supporting structure and tested for proper operation. Such testing shall include opening, closing, and operating all moving parts to ensure smooth operation and proper clearance, fit, and seating. The operating forces and opening and closing times shall be determined. The Contracting Officer shall be notified at least [7] [_____] calendar days prior to the start of testing and [all doors] [door [_____] [,] [_____] [,] [and] [_____]] shall be tested in the presence of the Contracting Officer. A test report shall be prepared and [three] [_____] copies furnished within [7] [_____] calendar days after testing.

2.6.4 Air Leakage Test

****
NOTE: Retain and edit this paragraph when door seals or thermal insulation are specified.
****

Each door assembly for which [door seals] [or] [thermal insulation] [are] [is] specified shall be factory tested for air leakage rate in accordance with ASTM E 283. The rate of air leakage per unit length of crack shall not exceed [0.20] [_____] cfm using a pressure difference of [1.57] [_____] psf. Prototype tests can be substituted for door assembly tests when the prototype door, frame, and hardware tested are equivalent to that provided or when otherwise approved.

2.6.5 Sound Rating Test

****
NOTE: Retain this paragraph when sound-rated hollow metal doors are specified.
****

The sound transmission class (STC) rating shall be determined in accordance with ASTM E 90.

2.6.6 Fire Rating Test and Inspection

****
NOTE: Retain this paragraph when fire rating is required. The door schedule on the drawings will indicate where fire-rated doors are to be used and their rating requirements.
****

Fire-rated door assemblies shall bear the listing identification label of the UL, or other nationally recognized testing laboratory qualified to perform tests of fire door assemblies in accordance with NFPA 252 and having a listing for the tested assemblies. Doors exceeding the size for which listing label service is offered shall be inspected in accordance with NFPA 80, NFPA 80A, and NFPA 101.

PART 3 EXECUTION

3.1 INSTALLATION

Doors and frames shall be installed in accordance with the manufacturer's written instructions. [Concrete shall be placed in reinforced concrete doors using the door manufacturer's standard forms.] [Pressed steel frames for hollow metal doors shall be fully grouted.] Exposed surfaces shall be finish painted in accordance with Section 09900 PAINTING, GENERAL. Galvanized surfaces damaged prior to final acceptance shall be repaired in accordance with ASTM A 780 to the same thickness as the original galvanizing.

3.2 TESTS

After installation is completed, each door shall be field tested for operation, clearance, fit, and seating by operating the door and hardware through at least 10 operating cycles. Door and hardware operation shall be tested using the forces specified. Personnel and equipment required to perform field testing shall be provided by the Contractor. Unless waived, all field tests shall be performed in the presence of the Contracting Officer. After testing is completed, test reports shall be prepared and [three] [_____] copies furnished.

3.3 MANUFACTURER'S FIELD SERVICE

Installation and testing of door assemblies shall be under the supervision of the door manufacturer's erection engineer. Upon completion of the work, and at a time designated by the Contracting Officer, the services of one engineer and other technical personnel as required shall be provided for a period of not less than [4] [_____] hours to instruct Government personnel in the operation and maintenance of the blast doors and all other items furnished under this specification section. The instructions shall also include use of the operation and maintenance manual. The instructions shall include videotapes. An instruction outline and procedure shall be submitted and approved prior to scheduling the instruction. One copy of all instruction material shall be provided at the time of instruction.

-- End of Section --

****

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SECTION 08520

ALUMINUM WINDOWS
08/98

****
NOTE: This guide specification covers the requirements for aluminum windows, accessories, and screens. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for awning/hopper/projected windows, casement windows, single-hung/double-hung windows, fixed windows, horizontal sliding windows, top-hinged windows, vertically/horizontally pivoted windows, and insect screens. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.
****

PART 1 GENERAL

****

NOTE: Drawings will indicate location, dimensions, elevations, schedules, content, details, and such other information as required to indicate the extent of the work.

Product selections shall be based on esthetic values, appearance, and cost as related to project needs.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF-45	(1997) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 101	(1997) Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors
AAMA 603	(1998) Voluntary Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum
AAMA 605	(1998) voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic coatings on Aluminum Extrusions and Panels
AAMA 1503	(1998) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3656	(1997) Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
ASTM E 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

ASTM E 330	(1997el Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
ASTM E 547	(1996) Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A39.1	(1995; A39.1a; A39.1b) Safety Requirements for Window Cleaning

INSECT SCREENING WEAVERS ASSOCIATION (ISWA)

ISWA IWS 089	(1990) Recommended Standards and Specifications for Insect Wire Screening (Wire Fabric)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(1997; Errata 97-1; TIA-97-1) Life Safety Code

SCREEN MANUFACTURERS ASSOCIATION (SMA)

SMA ANSI/SMA 1004	(1987) Aluminum Tubular Frame Screens for Windows

1.2 WINDOW PERFORMANCE

****

NOTE: Structural performance, air infiltration and water penetration are standard performance requirements for all aluminum window types. "Thermal Performance" is optional to designer, and applies only to thermal barrier windows. Omit portions of paragraph that do not apply.

****

Aluminum windows shall be designed to meet the following performance requirements. Testing requirements shall be performed by an independent testing laboratory or agency.

1.2.1 Structural Performance

Structural test pressures on window units shall be for positive load (inward) and negative load (outward) in accordance with ASTM E 330. After testing, there shall be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms or any other damage which could cause window to be inoperable. There shall be no permanent deformation of any main frame, sash or ventilator member in excess of the requirements established by AAMA 101 for the window types and classification specified in this section.

1.2.2 Air Infiltration

Air infiltration shall not exceed the amount established by AAMA 101 for each window type when tested in accordance with ASTM E 283.

1.2.3 Water Penetration

Water penetration shall not exceed the amount established by AAMA 101 for each window type when tested in accordance with ASTM E 547.

1.2.4 Thermal Performance

Thermal transmittance for thermally broken aluminum windows with insulating glass shall not be less than an R-Value of [R3.33] [R2.5] [_____] when tested in accordance with AAMA 1503.

1.2.5 Life Safety Criteria

****

NOTE: Designer must indicate on drawings which windows serve as rescue and/or secondary means of escape.

****

Windows shall conform to NFPA 101 Life Safety Code when rescue and/or second means of escape are indicated.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Aluminum Windows; [_____].

Manufacturer's descriptive data and catalog cut sheets.

SD-04 Drawings

Aluminum Windows; [_____]. Insect Screens; [_____].

Drawings indicating elevations of window, rough-opening dimensions for each type and size of window, full-size sections, thicknesses of metal, fastenings, methods of installation and anchorage, connections with other work, type of wall construction, size and spacing of anchors, method of glazing, types and locations of operating hardware, mullion details, weatherstripping details, [screen details including method of attachment,] [window cleaner anchor details], and window schedules showing locations of each window type.

SD-06 Instructions

Aluminum Windows; [_____].

Manufacturer's preprinted installation instructions and cleaning instructions.

SD-09 Reports

Aluminum Windows; [_____].

Reports for each type of aluminum window attesting that identical windows have been tested and meet all performance requirements established under paragraph WINDOW PERFORMANCE.

SD-13 Certificates

Aluminum Windows; [_____].

Certificates stating that the aluminum windows are AAMA certified conforming to requirements of this section. Labels or markings permanently affixed to the window will be accepted in lieu of certificates.

SD-14 Samples

Aluminum Windows; [_____].

Manufacturer's standard color samples of the specified finishes.

1.4 QUALIFICATION

Window manufacturer shall specialize in designing and manufacturing the type of aluminum windows specified in this section, and shall have a minimum of [_____] years of documented successful experience. Manufacturer shall have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

1.5 MOCK-UPS

****

NOTE: Requesting mock-up samples of aluminum windows is not required for most projects. Size of project and scope of quality control should be carefully evaluated before requiring Contractor to provide a costly mock-up. Delete paragraph if mock-ups are not required.

****

Before fabrication, full-size mock-up of [each type of aluminum window] [one window unit] [_____] complete with glass and AAMA certification label will be required for review of window construction and quality of hardware operation.

1.6 DELIVERY AND STORAGE

Aluminum windows shall be delivered to project site and stored in accordance with manufacturer's recommendations. Damaged windows shall be replaced with new windows.

1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2 PRODUCTS

2.1 ALUMINUM WINDOW TYPES

****

NOTE: Window types and window materials will be selected on the basis of functional requirements and economical considerations. Functional requirements include the operation of the window, consideration of the weather environment, conditions of usage, and aesthetic factors. Economic considerations include initial costs as well as maintenance costs over the life of the facility.

1. The grade designations denote the product's intended application: R for residential, LC for light commercial, C for commercial, HC for heavy commercial, and AW for Architectural. A minimum performance class is set for each grade: 15 for (R) windows (corresponding to a design pressure of 720 Pa (15 psf), 25 for (LC) windows, 30 for (C) windows, and 40 for (HC) and (AW) windows.

2. The designer can select a higher design pressure from among fifteen "Optional Performance Classes" shown in the following table. For example, if the minimum design pressure of 720 Pa (15 psf) is judged insufficient for a double-hung (H) residential window, the specifier may choose a window built to a design pressure of 1436 Pa (30 psf). The symbol would be H-R30 (instead of H-R15). The higher performance class, in addition to including a higher design pressure, also specifies correspondingly higher test criteria for uniform structural load and water resistance. Optional Performance Classes other than those specifically listed may be specified by setting any design pressure in increments of 250 Pa (5 psf). When an Optional Performance Class is specified, the following statement should be added: "Windows shall conform to Optional Performance Class [_____] when tested in accordance with AAMA 101."

OPTIONAL PERFORMANCE CLASSES ENGLISH

Optional Performance Class	Applicable Product Designation	*A Design Pressure lb/ft sq.	*B Structural Test Pressure lb/ft sq.	Water Resistance Test Pressure lb/ft sq.	
				R,C,HC	AW
20	R	20.0	30.0	3.00	
25	R	25.0	37.5	3.75	
30	R,LC	30.0	45.0	4.50	
35	R,LC,C	35.0	52.5	5.25	
40	R,LC,C	40.0	60.0	6.00	
45	R,LC,C,HC,AW	45.0	67.5	6.75	
50	R,LC,C,HC,AW	50.0	75.0	7.50	
55	R,LC,C,HC,AW	55.0	82.5	8.25	11.0
60	R,LC,C,HC,AW	60.0	90.0	9.00	12.0
65	R,LC,C,HC,AW	65.0	97.5	9.75	12.0
70	R,LC,C,HC,AW	70.0	105.0	10.50	12.0
75	R,LC,C,HC,AW	75.0	112.5	11.25	12.0
80	R,LC,C,HC,AW	80.0	120.0	12.00	12.0
85	R,LC,C,HC,AW	85.0	127.5	12.00	12.0
90	R,LC,C,HC,AW	90.0	135.0	12.00	12.0

*A. Design pressure = Performance Class

*B. Structural test pressures shown are for both positive and negative loads.

3. For projects which require security windows, refer to AR 190-51 "Security of Army Property at Unit and Installation Level" and Section 13958 FORCED ENTRY RESISTANT COMPONENTS.

4. For projects which require fire-rated windows to meet UL and NFPA requirements, specify a steel type unit as specified in Section 08510 STEEL WINDOWS; aluminum windows are not approved for this purpose.

5. For basements, projected windows shall be the inward swinging (project-in) type.

6. The hardware specified is typical for each window type. Refer to manufacturer's catalog for optional hardware selections.

7. Double glazed windows with a specified Condensation Resistance Factor (CRF) may be specified for occupied buildings such as barracks, medical facilities, administration buildings, etc. The CRF is a rating number, obtained under test

conditions, that predicts the point at which condensation will occur on either the glass or frame. Where outside temperature and inside humidity indicate that condensation may be a problem, the appropriate CRF should be inserted in the space provided.
****

Aluminum windows shall consist of complete units including sash, glass, frame, weatherstripping, [_____], and hardware. Windows shall conform to AAMA 101. Windows shall be [single-glazed] [double-glazed] [double-glazed and shall have a minimum condensation resistance factor of [_____] when tested in accordance with AAMA 1503]. Operable windows shall permit cleaning the outside glass from inside the building.

2.1.1 Awning/Hopper/Projected Windows

Aluminum awning (A) windows shall conform to AAMA 101 Designation [AP-R15] [AP-LC25] [AP-C30] [AP-HC40] [_____] type consisting of hinged ventilators arranged in a single or vertical series within a common frame. Ventilators shall be operated by a device which shall securely close the ventilator at both jambs without the use of additional manually-controlled locking device. Operating hardware except ventilator arms and rotary operators, shall be concealed within frame and sill. Ventilator arms shall be concealed when windows are closed.

2.1.2 Casement Windows

Aluminum casement (C) windows shall conform to AAMA 101 Designation [C-R15] [LC-25] [C-C30] [C-HC40] [C-AW40] type with ventilators which swing on side jamb. Hinges shall be [butt (close-up)] [_____] type. Operators shall be roto-type. Locking devices shall be provided to secure ventilators tightly in the frame in the closed position.

2.1.3 Single-Hung and Double-Hung Windows

****
NOTE: Double-hung or single-hung windows are typically used for living quarters and also for facilities with window air-conditioners.
****

Aluminum single-hung (H) and double-hung (H) windows shall conform to AAMA 101 [H-R15] [H-LC25] [H-C30] [H-HC40] [H-AW40] type which operate vertically with the weight of sash offset by a counterbalancing mechanism mounted in window to hold the sash stationary at any open position. Windows shall be provided with a tilt-in sash. Single-hung and double-hung windows shall be provided with locking devices to secure the sash in the closed position. Counterbalancing mechanisms shall be easily replaced after installation.

2.1.4 Fixed Windows

Aluminum fixed (F) windows shall conform to AAMA 101 [F-R15] [F-LC25] [F-C30] [F-HC40] [F-AW40] type, non-operable glazed frame, complete with provisions for reglazing in the field.

2.1.5 Horizontal-Sliding Windows

Aluminum horizontal (HS) sliding windows shall conform to AAMA 101 [HS-R15] [HS-LC25] [HS-C30] [HS-HC40] [HS-AW40] type consisting of sliding sash and fixed lite. Sash guides shall be nylon wheels. Windows shall be provided with locking devices to secure the sash in the closed position.

2.1.6   Top-Hinged Windows

Aluminum top-hinged (TH) (inswinging) windows shall conform to AAMA 101 [TH-C30] [TH-HC40] [TH-AW40] type consisting of a ventilator hinged to the main frame at the head to swing into the room. Hinges shall be [continuous applied type] [_____]. Holding devices shall be [hold-open arms attached to frame and ventilator] [removable stay-bar attached when ventilator is opened] to provide positive positioning of ventilator. Locking devices shall be type located at jambs and sill to secure the sash in the closed position.

2.1.7   Vertically/Horizontally Pivoted Windows

****

NOTE: Vertically/horizontally pivoted windows are typically used only for multistory buildings with year-round air-conditioning systems. This type of window should not be used for buildings where window washing can be accomplished more economically from outside.

****

Aluminum vertically/horizontally pivoted (VP) windows shall conform to AAMA 101 [VP-R15] [VP-LC25] [VP-C30] [VP-HC40] [VP-AW40] [_____] type consisting of a ventilator pivoted head and sill at the center of main frame which can reverse or rotate a full 360 degrees around the vertical axis, and be opened and held at 180 degrees. Pivot assemblies shall be designed to allow for removal of ventilator and provide for smooth operation of ventilator. Pivot assembly and locks shall be stainless steel, manganese bronze, aluminum alloy or other material compatible with aluminum. Pivot pins shall be stainless steel. Windows shall be provided with devices to secure the sash in the closed position.

2.2   WEATHERSTRIPPING

Weatherstripping for ventilating sections shall be of type designed to meet water penetration and air infiltration requirements specified in this section in accordance with AAMA 101, and shall be manufactured of material compatible with aluminum and resistant to weather. Weatherstrips shall be factory-applied and easily replaced in the field. Neoprene or polyvinylchloride weatherstripping are not acceptable where exposed to direct sunlight.

2.3   INSECT SCREENS

****

NOTE: Screens are typically not required for air-conditioned buildings or spaces. To prevent entry of flying insects, screens are typically used in medical facilities, food preparation areas, dining areas, sleeping areas, and similar locations when these facilities are not air-conditioned.

Screen locations, sizes, and mounting types, such as outside or inside, should be indicated on drawings.
****

Insect screens shall be aluminum window manufacturer's standard design, and shall be provided where scheduled on drawings. Insect screens shall be fabricated of roll-formed tubular-shaped [aluminum frames conforming to SMA ANSI/SMA 1004 and (18 x 16) [aluminum mesh screening conforming with ISWA IWS 089, Type III] [vinyl coated glass screening conforming to ASTM D 3656].] [stainless steel frames conforming to SMA ANSI/SMA 1004 and (18 x 16) bronze mesh screening conforming with ISWA IWS 089, Type I.]

2.4 ACCESSORIES

2.4.1 Fasteners

Fastening devices shall be window manufacturer's standard design made from aluminum, stainless steel, cadmium-plated steel, nickel/chrome-plated steel in compliance with AAMA 101. Self-tapping sheet metal screws will not be acceptable for material thicker than 1/16 inch.

2.4.2 Hardware

Hardware shall be as specified for each window type and shall be fabricated of aluminum, stainless steel, cadmium-plated steel, zinc-plated steel or nickel/chrome-plated steel in accordance with requirements established by AAMA 101.

2.4.3 Window Anchors

Anchoring devices for installing windows shall be made of aluminum, cadmium-plated steel, stainless steel, or zinc-plated steel conforming to AAMA 101.

2.4.4 Window Cleaner Anchors

****
NOTE: The designer should determine when window cleaning anchors are required. If outside face of glass is to be cleaned from the inside, delete requirements for window-cleaner anchors.
****

Window cleaner anchors shall be manufactured of stainless-steel conforming to ASME A39.1. Window frames shall be reinforced to receive window cleaner anchors. Locations of window cleaner anchors shall be as shown.

2.5 GLASS AND GLAZING

****
NOTE: Coordinate project window requirements with aluminum window manufacturer's "standard" glass for windows and Section 08810 GLASS AND GLAZING. Inside glazing should be specified but may not be available for double-hung windows; verify with manufacturer's data. Double-glazing may be used in accordance with TI 800-01 Design Criteria. When double-glazing is used, specify "Thermal Performance" indicated in

paragraph under "WINDOW PERFORMANCE".

Determination and use of the CRF is described in AAMA 1502.7. The appropriate Condensation Resistance Factor should be selected from the following table:

MINIMUM RECOMMENDED CONDENSATION RESISTANCE FACTOR (CRF) METRIC

OUTSIDE DESIGN TEMPERATURE	10%	15%	20%	25%	30%	35%	40%	45%	50%
- 34 deg. C	43	51	57	26	67	71	74	78	80
- 32 deg. C	40	49	55	60	65	69	73	77	79
- 29 deg. C	37	46	53	58	63	68	71	75	78
- 26 deg. C	33	42	50	56	61	66	70	74	77
- 23 deg. C	29	39	46	53	58	63	68	72	75
- 21 deg. C	24	35	43	49	55	61	65	70	73
- 18 deg. C	18	30	39	46	52	58	63	68	71
- 15 deg. C	12	24	34	41	48	55	60	65	69
- 12 deg. C	4	18	28	36	44	51	57	62	67
- 9 deg. C		10	21	30	38	46	52	59	63
- 7 deg. C			13	23	32	40	48	55	60
- 4 deg. C			3	14	24	33	41	49	55
- 1 deg. C				3	14	25	34	43	49

MINIMUM RECOMMENDED CONDENSATION RESISTANCE FACTOR (CRF) ENGLISH

OUTSIDE DESIGN TEMPERATURE	10%	15%	20%	25%	30%	35%	40%	45%	50%
- 30 deg. F	43	51	57	26	67	71	74	78	80
- 25 deg. F	40	49	55	60	65	69	73	77	79
- 20 deg. F	37	46	53	58	63	68	71	75	78
- 15 deg. F	33	42	50	56	61	66	70	74	77
- 10 deg. F	29	39	46	53	58	63	68	72	75
- 5 deg. F	24	35	43	49	55	61	65	70	73
0 deg. F	18	30	39	46	52	58	63	68	71
+ 5 deg. F	12	24	34	41	48	55	60	65	69
+ 10 deg. F	4	18	28	36	44	51	57	62	67
+ 15 deg. F		10	21	30	38	46	52	59	63
+ 20 deg. F			13	23	32	40	48	55	60
+ 25 deg. F			3	14	24	33	41	49	55
+ 30 deg. F				3	14	25	34	43	49

2: Window manufacturer must be consulted to determine availability of units with CRF higher than 62.

3: The table is based on 20 degrees C (68 degrees F) inside

MINIMUM RECOMMENDED CONDENSATION RESISTANCE FACTOR (CRF) ENGLISH temperature and an outside wind velocity of 24 km (15 miles) per hour.
****

Aluminum windows shall be designed for inside glazing, field glazing, and for glass types scheduled on drawings and specified in Section 08810 GLASS AND GLAZING. Units shall be complete with glass and glazing provisions to meet AAMA 101. Glazing material shall be compatible with aluminum, and shall not require painting.

2.6 FINISH

****
NOTE: Anodic coatings and baked-acrylic resin-based coatings are typically used for economic reasons. High-performance fluoropolymer coatings cost more than anodizing or resin-based coatings but is a very durable coating with excellent colorfastness. For a broader selection, refer to Aluminum Association AA DAF-45 publication "Designation System for Aluminum Finishes" which establishes a wide range of coatings and colors.
****

2.6.1 Anodized Aluminum Finish

****
NOTE: The 0.010 mm (0.4 mil) thick anodized finish costs less than 0.02 mm (0.7 mil) thickness but is more easily scratched and not as durable in appearance and performance as 0.02 mm (0.7 mil) thickness.
****

Exposed surfaces of aluminum windows shall be finished with anodic coating conforming to AA DAF-45: [Architectural Class II, AA-M10-C22-A31, clear anodic coating, 0.4 to 0.7 mil thick, 204-R1 Natural Color] [Architectural Class I, AA-M10-C22-A41, clear anodic coating, 0.7 milor thicker, 215-R1 Natural Color] [Architectural Class I, AA-M10-C22-A44, color anodic coating, 0.7 mil or thicker]. Finish shall be free of scratches and other blemishes.

2.6.2 Baked-Acrylic Resin-Based Coating

Exposed surfaces of aluminum windows shall be finished with acrylic resin-based coating conforming to AAMA 603, total dry thickness of 1.0 mils. Finish shall be free of scratches and other blemishes.

2.6.3 High-Performance Coating

Exposed surfaces of aluminum windows shall be finished with a two-coat fluoropolymer coating system containing at least 70 percent by weight polyvinylidene fluoride, PVF2 resin, factory-applied, oven-baked, conforming to AAMA 605, with a primer coat of 0.20 to 0.30 mils and a color coat of minimum 1.0 mils, total dry film thickness of 1.20 to 1.3

mils. Finish shall be free of scratches and other blemishes.

2.6.4   Color

Color shall be in accordance with [Section 09915 COLOR SCHEDULE] [_____].

PART 3   EXECUTION

3.1   INSTALLATION

Aluminum windows shall be installed in accordance with approved shop drawings and manufacturer's published instructions. Aluminum surfaces in contact with masonry, concrete, wood and dissimilar metals other than stainless steel, zinc, cadmium or small areas of white bronze, shall be protected from direct contact using protective materials recommended by AAMA 101. The completed window installation shall be watertight in accordance with Section 07900 JOINT SEALING. Glass and glazing shall be installed in accordance with requirements of this section and Section 08810 GLASS AND GLAZING.

3.2   ADJUSTMENTS AND CLEANING

3.2.1   Hardware Adjustments

Final operating adjustments shall be made after glazing work is complete. Operating sash or ventilators shall operate smoothly and shall be weathertight when in locked position.

3.2.2   Cleaning

Aluminum window finish and glass shall be cleaned on exterior and interior sides in accordance with window manufacturer's recommendations. Alkaline or abrasive agents shall not be used. Precautions shall be taken to avoid scratching or marring window finish and glass surfaces.

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-08700 (March 1996)**
U.S. ARMY CORPS OF ENGINEERS | **-------------------------**
Superseding
CEGS-08700 (October 1991)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 6 (May 1999)
Includes Special Change (Tailoring Options) (July 1998)
Includes Text Adjustment Change (Section Reference) (June 1997)

Latest change indicated by CHG tags

****

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03/96

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SECTION 08700

BUILDERS' HARDWARE
03/96

****

NOTE: This guide specification covers the requirements for builders hardware for a wide range of applications. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for exit devices/exit device access, delayed egress locks, door controls-overhead hldrs, smoke detectors/electro-mag hldrs, power assist/low energy power oper, and auxiliary hardware. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen
ASTM F 883	(1997) Padlocks

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA L & R Directory	(Effective thru Jun 1999) Directory of Certified Locks & Latches
BHMA Closer Directory	(Effective thru Jul (1999) Directory of Certified Door Closers
BHMA Exit Devices Directory	(Effective thru Aug 1998) Directory of Certified Exit Devices
BHMA A156.1	(1997) Butts and Hinges
BHMA A156.2	(1996) Bored and Preassembled Locks and Latches
BHMA A156.3	(1994) Exit Devices
BHMA A156.4	(1992) Door Controls - Closers
BHMA A156.5	(1992) Auxiliary Locks & Associated Products
BHMA A156.6	(1994) Architectural Door Trim
BHMA A156.7	(1997) Template Hinge Dimensions
BHMA A156.8	(1994) Door Controls - Overhead Stops and Holders
BHMA A156.13	(1994) Mortise Locks & Latches
BHMA A156.15	(1995) Closer Holder Release Devices
BHMA A156.16	(1989) Auxiliary Hardware

BHMA A156.17	(1993) Self Closing Hinges & Pivots
BHMA A156.18	(1993) Materials and Finishes
BHMA A156.19	(1997) Power Assist and Low Energy Power Operated Doors
BHMA A156.20	(1996) Strap and Tee Hinges and Hasps
BHMA A156.21	(1996) Thresholds
BHMA A156.23	(1992) Electromagnetic Locks
BHMA A156.24	(1992) Delayed Egress Locks

DOOR AND HARDWARE INSTITUTE (DHI)

DHI Keying Systems	(1989) Keying Systems and Nomenclature
DHI Locations for CSD	(1997) Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames
DHI Locations for SSD	(1990) Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames
DHI ANSI/DHI A115.1G	(1994) Installation Guide for Doors and Hardware
DHI ANSI/DHI A115-W	(Varies) Wood Door Hardware Standards (Incl All5-W1 thru A115-W9)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1999) Fire Doors and Fire Windows
NFPA 101	(1997; Errata 97-1; TIA-97-1) Life Safety Code
NFPA 105	(1999) Installation of Smoke-Control Door Assemblies

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation;

submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Hardware and Accessories; [_____].

Manufacturer's descriptive data, technical literature, catalog cuts, and installation instructions. Spare parts data for locksets, exit devices, closers, electric locks, electric strikes, electro-magnetic closer holder release devices, and electric exit devices, after approval of the detail drawings, and not later than [1] [3] [_____] month(s) prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-04 Drawings

Hardware Devices; GA.

Detail drawings for hardware devices for computerized keying systems, magnetic cards, keyless push button access control systems, and other electrical hardware devices showing complete wiring and schematic diagrams and other details required to demonstrate proper function of units.

SD-07 Schedules

Hardware Schedule; [_____].

Hardware schedule listing all items to be furnished. The schedule shall include for each item: the quantities; manufacturer's name and catalog numbers; the ANSI number specified, sizes; detail information or catalog cuts; finishes; door and frame size and materials; location and hardware set identification cross-references to drawings; corresponding reference standard type number or function number from manufacturer's catalog if not covered by ANSI or BHMA; and list of abbreviations and template numbers.

Keying Schedule; GA.

Keying schedule developed in accordance with DHI Keying Systems, after the keying meeting with the user.

SD-13 Certificates

Hardware and Accessories; [_____].

The hardware manufacturer's certificates of compliance stating that the supplied material or hardware item meets specified requirements. Each certificate shall be signed by an official authorized to certify in behalf of the product manufacturer and shall identify quantity and date or dates of shipment or delivery to which the certificates apply. A statement that the proposed hardware items appear in BHMA L & R Directory, BHMA Closer Directory and BHMA Exit Devices Directory directories of certified products may be submitted in lieu of certificates.

1.3 PREDELIVERY CONFERENCE

Upon approval of the Hardware Schedule, the construction Contractor shall arrange a conference with the hardware supplier, Contracting Officer and the using agency to determine keying system requirements. Location of the key control storage system, set-up and key identification labeling will also be determined.

1.4   DELIVERY, STORAGE, AND HANDLING

Hardware shall be delivered to the project site in the manufacturer's original packages. Each article of hardware shall be individually packaged in the manufacturer's standard commercial carton or container, and shall be properly marked or labeled to be readily identifiable with the approved hardware schedule. Each change key shall be tagged or otherwise identified with the door for which its cylinder is intended. Where double cylinder functions are used or where it is not obvious which is the key side of a door, appropriate instructions shall be included with the lock and on the hardware schedule. Manufacturer's printed installation instructions, fasteners, and special tools shall be included in each package.

1.5   SPECIAL TOOLS

Special tools, such as those supplied by the manufacturer, unique wrenches, and dogging keys, shall be provided as required to adjust hardware items.

1.6   WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

1.7   OPERATION AND MAINTENANCE MANUALS

[Six] [_____] complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides shall be provided. The instructions for electric locks, electric strikes, electro-magnetic closer holder release devices, and electric exit devices shall include simplified diagrams as installed.

PART 2   PRODUCTS

2.1   GENERAL HARDWARE REQUIREMENTS

Hardware shall conform to the requirements specified herein and the HARDWARE SETS listing at the end of this section. Hardware set numbers correspond to the set numbers shown on the drawings.

2.2   TEMPLATES

Requirements for hardware to be mounted on metal doors or metal frames shall be coordinated between hardware manufacturer and door or frame manufacturer by use of templates and other information to establish location, reinforcement required, size of holes, and similar details. Templates of hinges shall conform to BHMA A156.7.

2.3   HINGES

****

NOTE: Hinges for doors in hospitals will be specified to have hospital tips where applicable (usually only in psychiatric areas).

Doors equipped with overhead closers will have ball

bearing or other anti-friction hinges. Grade 1 hinges normally will be used on doors which are unusually heavy, subjected to unusual stress, or are very high frequency use. Grade 2 hinges normally will be used on high frequency use doors.

For outswinging exterior doors and for interior doors subject to high humidity and/or corrosive conditions, nonferrous hinges or stainless steel hinges should be used. Fire rated doors similarly located should have stainless steel hinges.

Hinges with loose pins on outswinging exterior doors will be specified with nonremovable pins or safety stud.

Use two hinges for doors up to 1500 mm (5 feet) high, three hinges for doors from 1.5 to 2.25 mm (5 feet to 7 feet 6 inches) and one additional hinge for every additional 750 mm (30 inches) or fraction thereof in height.

See TABLE I for types of hinges to be used for various door and frame materials. When necessary to specify hinge size in the hardware set listing, see TABLE II for hinge sizes.

TABLE I. HINGE SELECTION CHART

Door and Frame	Wood Door With Wood or Hollow Metal Frame, Hollow Metal Door with Hollow Metal Frame	Hollow Metal Door with Channel Frame	Mineral Core Wood or Kalamein Door with Kalamein or Hollow Metal Frame	Mineral Core Wood or Kalamein Door With Channel Frame
Type of Hinge	Full Mortise	Half Mortise	Half Surface	Full Surface
Plain-Bearing:				
Brass, Bronze	A2133	A2233	A2433	A2333
Stainless Steel	A5133	A5233	--	--
Steel	A8133	A8233	A8433	A8333
Antifriction Bearing Standard Weight:				
Brass, Bronze	A2112	A2212	A2412	A2312
Stainless Steel	A5112	A5212	A5412	A5312
Steel	A8112	A8212	A8412	A8312
Antifriction Bearing Heavy Weight:				

TABLE I. HINGE SELECTION CHART

Door and Frame	Wood Door With Wood or Hollow Metal Frame, Hollow Metal Door with Hollow Metal Frame	Hollow Metal Door with Channel Frame	Mineral Core Wood or Kalamein Door with Kalamein or Hollow Metal Frame	Mineral Core Wood or Kalamein Door With Channel Frame
Type of Hinge	Full Mortise	Half Mortise	Half Surface	Full Surface
Brass, Bronze	A2111	A2211	A2411	A2311
Stainless Steel	A5111	A5211	A5411	A5311
Steel	A8111	A8211	A8411	A8311

NOTES ON THE USE OF TABLE I

a. Refer to BHMA A156.1 for listing of hinge types and options. Specify options following the designation of hinge type; e.g., A8111 w/Hospital Tips. Requirements for nonremovable pins (NRP) and template hinges have been included in the body of this specification.

b. Weight of door and frequency of use determine hinge weight and bearing structure. Frequency refers to the number of times a door is opened and closed during a set period of time.

c. This table shows types of hinges generally used with door and frame materials listed. Use appropriate designations from BHMA A156.1 if other types are required.

d. Hinges for labeled fire doors must be steel or stainless steel. Specify half-surface hinges for mineral core wood or Kalamein doors to be through-bolted to the doors. Specify back plates for attaching hinges to mineral core wood doors.

TABLE II. HINGE SIZES CHART

Thickness of Doors in mm (Inches)	Width of Doors in mm (Inches)	Height of Hinge (Length of Joint) in mm (Inches)
22 - 29 (7/8 - 1-1/8 screen)	To 915 (36)	76.2 (3)
35 (1-3/8)	To 810 (32)	88.9 (3-1/2)
35 (1-3/8)	Over 810 to 940 (32 - 37)	101.6 (4)

TABLE II. HINGE SIZES CHART

Thickness of Doors in mm (Inches)	Width of Doors in mm (Inches)	Height of Hinge (Length of Joint) in mm (Inches)
44 (1-3/4)	To 915 (36)	114.3 (4-1/2)
44 (1-3/4)	Over 915 to 1220 (36 - 48)	127.0 (5) H/W
44 (1-3/4)	Over 1220 (48)	152.4 (6) H/W
51 57 & 63 (2, 2-1/4 & 2-1/2)	To 1060 (42)	127.0 (5) H/W
51 57 & 63 (2, 2-1/4 & 2-1/2)	Over 1060 (42)	152.4 (6) H/W

NOTES ON THE USE OF TABLE II

a. Select and size hinges for lead-lined, unusually heavy, and high frequency doors on an individual basis. Lead lined doors may pose a problem, in that pivots may be necessary in lieu of hinges. Manufacturers weight limitations must be referred to when selecting hinges or pivots for lead lined doors.

b. The 114.3 by 114.3 mm (4-1/2 by 4-1/2 inches) specified is for 44 mm (1-3/4 inch) doors up to 915 mm (3 feet) wide and with up to 19 mm (3/4 inch) trim projection, and covers a vast majority of applications. For other doors, determine hinge width in accordance with the following formula:

Twice the door thickness plus trim projection, minus 13 mm (1/2 inch), or 2(t plus p)-13 (1/2). If answer falls between regular hinge sizes, use nearest larger size. Formula is for hinges set back 6 mm (1/4 inch) from edge of door.

Pivots may be considered for extra heavy doors such as lead-lined doors. Pivots that permit vertical adjustment are preferred. Center hung pivots are used on double acting doors and generally in connection with floor closers. Offset pivots and intermediate pivots are used on single acting doors.

****

Hinges shall conform to BHMA A156.1. Hinges used on metal doors and frames shall also conform to BHMA A156.7. Except as otherwise specified, hinge sizes shall conform to the hinge manufacturer's printed recommendations.

2.3.1 Hinges for Reverse Bevel Doors with Locks

Hinges for reverse bevel doors with locks shall have pins that are made nonremovable by means such as a set screw in the barrel, or safety stud, when the door is in the closed position.

2.3.2   Contractor's Option

Hinges with antifriction bearings may be furnished in lieu of ball bearing hinges, except where prohibited for fire doors by the requirements of NFPA 80.

2.3.3   Pivot Hinges

Pivot hinges shall conform to BHMA A156.4.

2.3.4   Spring Hinges

Spring hinges shall conform to BHMA A156.17.

2.3.5   Electric Hinges

Electric hinges shall conform to BHMA A156.1 with modification of added electric wires to insure correct operation of electric hardware items.

2.4   LOCKS AND LATCHES

****

NOTE: Locksets for sleeping room entry doors in barracks will conform to BHMA A156.13, function F-13, without stopworks, with key-removable core cylinder. Deadbolt throw shall be 25 mm (1 inch).

Additional replacement cores and keys will be specified (a minimum of 10 percent of total locksets procured) to allow core interchanges. Where the barracks design requires a lockable outer door (regional barracks design) a function F-13 mortise lockset will be specified as described above and an independent keying system will be implemented. This would require the occupant to maintain two keys to get to his/her sleeping quarters. The outer door lockset will also incorporate removable core cylinder that will allow easy lock changes.

****

To the maximum extent possible, locksets, latchsets and deadlocks, and all components thereof, including cylinders and removable cores, shall be the products of a single manufacturer. Lock fronts for double-acting doors shall be rounded. Strikes for wood frames and pairs of wood doors shall be furnished with wrought boxes.

2.4.1   Mortise Lock and Latchsets

****

NOTE: BHMA standards for locksets should be carefully reviewed when specifying series and grade required. When a deadbolt is required for additional security, mortise locksets and latches should be considered in lieu of bored locksets with separate deadbolt. Security grade, Grades 1, 2, or 3, mortise locks complying with BHMA A156.13 will be

specified in HW-set listings when extra strength is required. Functions available under BHMA A156.13 are limited and the standard must be reviewed. All dead bolts should have a 25 mm (1 inch) throw. Lever handles will be used when required by the Uniform Federal Accessibility Standards as an aid to physically handicapped persons. Bored locksets with lever handles on both sides of the door have limited availability in many locking functions listed in BHMA A156.2. Mortise locks with lever handles may be more cost effective than bored locks. Verify costs and availability when specifying lever handles.
****

Mortise lock, latchsets, and strikes shall be series 1000 and shall conform to BHMA A156.13, operational Grade 1. [Strikes for security doors shall be rectangular without curved lip.] Mortise type locks and latches for doors 1-3/4 inches thick and over shall have adjustable bevel fronts or otherwise conform to the shape of the door. Mortise locks shall have armored fronts.

2.4.2 Bored Lock and Latchsets

****
NOTE: Coordinate with paragraph MORTISE LOCK AND LATCHSETS.
****

Bored lock, latchsets, and strikes shall be series 4000 and shall conform to BHMA A156.2, Grade 1. Bored type locks and latches for doors 1-3/8 inches thick and over shall have adjustable bevel fronts or otherwise conform to the shape of the door.

2.4.3 Electro-Mechanical Locks

****
NOTE: Electrically operated door locks and strikes are available. Electric bolt retraction allows door to be operated in a push-pull manner and may be used to provide additional security for doors with automatic door openers. Electric strike with fail safe feature will not be used for fire doors as they will not meet positive latch requirements. Magnetic locks will fail safe on loss of electric power, and will not be used on fire doors. Magnetic locks will not be used as the only locking device on doors to secure areas. When electrically operated locks, bolt retraction, or electric strikes are required, designers should consult manufacturers or manufacturers' literature for proper selection. Power, wiring, transformers, converters, and wiring devices will be coordinated with the electrical drawings.
****

Electro-mechanical locks shall allow for [locking] [or] [unlocking] of doors from a remote location by means of [push buttons] [card reader]

[_____]. Locks shall be [fail safe mode (unlocked when power is off)] [fail secured mode (exterior side only locked when power is off)]. Locks shall be mortise series conforming to BHMA A156.13 and bored series conforming to BHMA A156.2 with factory installed electric lock modification or manufactured electro-mechanical locks conforming to BHMA A156.13 or BHMA A156.2 test standards. [In hazardous locations, products shall use safe power supplies or be pneumatic.]

2.4.4 Auxiliary Locks and Associated Products

****

NOTE: Coordinate with paragraph ELECTRO-MECHANICAL LOCKS.

****

Bored and mortise dead locks and dead latches, narrow style dead locks and dead latches, rim latches, dead latches, and dead bolts, and electric strikes shall conform to BHMA A156.5. [Bolt and latch retraction shall be dead bolt style.] Strike boxes shall be furnished with dead bolt and latch strikes for Grade 1. Electric strikes shall be [locked] [or] [unlocked] from a remote location in [fail safe] [fail secured] mode. Electric strike for rated openings shall be fail secured.

2.4.5 Lock Cylinders (Mortise, Rim and Bored)

****

NOTE: Six-pin cylinders will normally be specified for general-purpose construction. Seven-pin cylinders should be specified for more complicated master keyed systems. Removable cores will be specified only where frequent key changes are required. Bit key operated locks may be required in lieu of cylinder operated for asylum type construction. Where security grade cylinders are required, a suffix "A" may be added for drill and pick resistant cylinders. Cylinders compatible with most existing systems can be furnished by multiple manufacturers. In an unusual case where there is only one manufacturer compatible with the existing system, full Justification and Approval in accordance with FAR 6.303 must be prepared to support a sole-source specification.

A patented, customized key control system, manufactured by InstaKey Lock Corporation, is available through the General Services Administration, 819 Taylor Street,Room 6A24, Ft. Worth, Texas 76102-6114, telephone (817) 978-8370 or the Defense Industrial Supply Center, telephone (215) 697-5605. All lock cylinders and removable cores will be government furnished equipment (GFE) when the using agency requests or directs that InstaKey be incorporated into the facility design. The using agency will be responsible for purchasing these items and establishing the keying and master keying requirements with InstaKey. Actual purchase

order cannot be finalized until the construction contract is awarded and manufacturers of locksets, exit devices, etc., are determined. Where this system is to be used, delete the entire text of this paragraph and replace it with: "Lock cylinders will be furnished by the Government and installed by the Contractor. The Contractor shall furnish all construction cylinders required by the Contractor's own security requirements and shall remove and retain them upon installation of the Government furnished cylinders."
****

Lock cylinders shall comply with BHMA A156.5. Lock cylinder shall have not less than [six] [seven] pins. [Cylinders shall have key removable type cores.] [A [great] [grand] master keying system shall be provided.] [An extension of the existing keying system shall be provided. The cylinders shall be compatible with existing locks that were manufactured by [_____], [do not] have interchangeable cores and have a [_____] type keyway.] [[A construction master keying system] [Construction interchangeable cores] shall be provided.] [Disassembly of knob or lockset shall not be required to remove core from lockset.] [All locksets, lockable exit devices, and padlocks shall accept same interchangeable cores.]

2.4.6 Locksets for Lead-Shielded Doors

****
NOTE: There is a relatively limited selection of locksets available with lead linings. When lead-shielded doors are to be specified, the specifier should coordinate scheduling of hardware for lead-shielded doors with hardware manufacturers.
****

Locksets for lead-shielded doors shall be provided with factory-installed lead linings. Lead linings shall not be less than the thickness of the lead in the door in which the lockset is required.

2.4.7 Padlocks

****
NOTE: Type PO1 is key operated; Grade 6 is the top grade commercial lock; in option A the key is captive in cylinder where padlock is unlocked, in Option B the cylinder is removable; Option G is Environmental resistant. For combination locks or other options and grades see ASTM F 883.
****

Padlocks shall conform to ASTM F 883, Type [PO1] [_____], Option[s] [A, B and G] [_____]. Grade [6] [_____]. [All padlocks shall be keyed alike]. [All padlocks shall be keyed into master key system].. Straps, tee hinges, and hasps shall conform to BHMA A156.20.

2.4.8 Push/Pull Latches

****

NOTE: Push/pull latches are available from a limited number of hardware manufacturers and are not included in BHMA or any other national standard. Such devices should be specified only for hospitals and similar facilities where doors must be operable without use of hands. Consult manufacturers literature for specification data.
****

2.4.9 Lock Trim

****
NOTE: Specific design of trim to be used should be added if required to match existing or for other specific reasons.
****

Lock trim shall be cast, forged, or heavy wrought construction of commercial plain design. In addition to meeting the test requirement of BHMA A156.2 or BHMA A156.13, knobs, lever handles, roses, and escutcheons shall be 0.050 inch thick, if unreinforced. If reinforced, the outer shell shall be 0.035 inch thick and the combined thickness shall be 0.070 inch except that knob shanks shall be 0.060 inchthick. Knob diameter shall be 2-1/8 to 2-1/4 inches.Lever handles shall be of plain design with ends returned to no more than 1/2 inch from the door face.

2.4.10 Electromagnetic Locks

****
NOTE: Electromagnetic locks may be used with security systems to control unauthorized access, to control access to areas containing hazardous operations and with delayed egress locks. Electromagnetic locks shall be used only when the building is protected throughout by an automatic fire detection and/or sprinkler system that releases the locks upon activation of the fire or sprinkler alarm. Refer to BHMA A156.23 and applicable codes for additional limitations of use.
****

Electromagnetic locks shall allow for [locking] [or] [unlocking] of doors from a remote location by means of [push buttons] [card reader] [_____]. Electromagnetic locks shall be fail safe (unlocked when power is off) and shall conform to BHMA A156.23. [In hazardous locations, products shall use safe power supplies.]

2.5 EXIT DEVICES AND EXIT DEVICE ACCESSORIES

Exit devices and exit device accessories shall conform to BHMA A156.3, Grade 1.

2.5.1 Exit Devices and Auxiliary Items

Trim shall be of wrought construction and commercial plain design with straight, beveled, or smoothly rounded sides, corners, and edges. Adjustable strikes shall be provided for rim type and vertical rod devices.

Open back strikes shall be provided for pairs of doors with mortise and vertical rod devices; except open back strikes shall be used on labeled doors only where specifically provided for in the published listings. [Touch bars [may] [shall] be provided in lieu of conventional crossbars and arms.] [Escutcheons shall be provided not less than 7 by 2-1/4 inches. Escutcheons shall be cut to suit cylinders and operating trim.]

2.5.2   Door Coordinator

****

NOTE: Overlapping astragals should be used only when necessary. Overlapping astragals will not be specified on pairs of doors where both leaves are equipped with vertical rod exit devices. Pairs of fire doors without astragals and having ratings through 1-1/2 hours are available from some door manufacturers.

****

Door coordinator with carry bar shall be Type 21 and shall be provided for each pair of doors equipped with an overlapping astragal. The coordinator may be [gravity] [mechanically] operated and shall be capable of holding the active door of a pair open until the inactive door has preceded it in the closing cycle. When used as fire exit hardware, the coordinator and carry bar shall be listed or labeled by a nationally recognized independent testing laboratory.

2.5.3   Removable Mullions

Removable mullions shall be Type 22 of the box type and shall be used only with those exit devices for which the mullions were manufactured. Mullions shall be furnished with mullion stabilizers of the same manufacturer.

2.5.4   Electric Exit Devices

****

NOTE: Identify performance requirements such as monitor doors, sound alarms, or work in conjunction with automatic operators in any opening, rated or nonrated. Some devices may lock or unlock trim; others may work the latch bolts.

****

Electric exit devices shall conform to BHMA A156.3 with factory installed electric lock modification having the capability to [lock] [or] [unlock] from remote location by means of [push button] [card reader] [_____]. Exit devices shall comply with life safety requirements of NFPA 101. [In hazardous locations, products shall use safe power supplies or be pneumatic.]

2.5.5   Automatic Flush Bolts

Automatic flush bolts shall be Type 25 in accordance with BHMA A156.3, and shall be installed at the top and bottom of the inactive leaf of pairs of fire rated doors where specified in the hardware sets. Flush bolts shall be mortised in the strike edge of the door.

2.6   DELAYED EGRESS LOCKS

****

NOTE: A delayed egress lock is a device or combination of devices, used in connection with conventional exit devices or locks, which sounds an alarm when the normal releasing process is initiated and prevents the door from opening for predetermined time interval. The use of delayed egress locks shall be limited to doors having an exit only function in facilities when security considerations require alerting other personnel before an unauthorized door opening can occur. Examples of proper use are commissaries, post exchanges, and secure areas containing classified information. Refer to BHMA A156.24 and applicable Codes for additional requirements and limitations of use.

****

Delayed egress locking devices shall comply with BHMA A156.24. Each delayed egress lock shall have a sign that reads "PUSH UNTIL ALARM SOUNDS, DOOR CAN BE OPENED IN [15] [_____] SECONDS". Sign letters shall be 1 inch high with 1/8 inch wide stroke. The sign shall be for mounting on the [door] [wall] near the delayed egress lock. [In hazardous locations, products shall use safe power supplies.]

2.7 KEYING

****

NOTE: When construction keys are specified, the following will be added to the paragraph: "Permanent keys shall be sent by the lock manufacturer directly to the Contracting Officer by registered mail or other approved means."

Control keys shall be specified whenever lock cylinders with removable cores are specified.

The keying and master keying requirements will be obtained from the using agency and the precise method or arrangement of setting up these requirements will be determined after the hardware schedule is approved. Proprietary systems will not be specified unless they have been fully justified and reported in advance of advertisement for bids. The use of a proprietary system will not be considered properly justified unless the report contains a completely logical reason why the system named is properly the one which should be specified. For example, specification of a proprietary lockset system will not be considered justifiable unless such system is for a logically designated area within which earlier installations are predominantly of the manufacturer being specified. Where an integrated master keying system is required, and a proprietary system is justified, the name of the

manufacturer whose locks are presently installed at the facility will be specified and followed by a statement requiring integrated keying with that system.

Where the using agency requires a key storage system, instructions will be obtained from that agency regarding the type, class, system, and capacity of the desired storage system and its preferred location in the finish work.

Where Government furnished lock cylinders are specified in paragraph Lock Cylinders (Mortise, Rim and Bored), keying of locks will be part of the GFE package. Delete the entire text of this paragraph and replace it with: "All keys and keying requirements are included with the Government furnished cylinders."
****

Locks shall be keyed in sets or subsets as scheduled. [Locks shall be furnished with the manufacturer's standard construction key system.] Change keys for locks shall be stamped with change number and the inscription "U.S. Property - Do Not Duplicate." Keys shall be supplied as follows:

Locks:	3 change keys each lock.
Master keyed sets:	[_____] keys each set.
Grand master keys:	[_____] total.
[Control keys:	[_____] total.]
[Construction keys:	[_____] total.]
[Blank keys:	[_____] total.]

The keys shall be furnished to the Contracting Officer arranged [in a container] [for key control system storage] in sets or subsets as scheduled.

2.8 DOOR CLOSING DEVICES

****
NOTE: Closing devices for doors required to be accessible to persons with disabilities shall be noted "Low Opening Resistance" in Paragraph HARDWARE SETS.
****

Door closing devices shall conform to BHMA A156.4, Grade 1. Closing devices shall be products of one manufacturer for each type specified. The opening resistance of closing devices shall not exceed 15 1bf applied at the latch stile or exceed 5 1bfwhere low opening resistance is scheduled.

2.8.1 Surface Type Closers

****
NOTE: Series C01000 traditional type closers should be limited to use on shops, storage buildings, warehouses, or similar type buildings where appearance is not important. A limited number of

manufacturers make this series; therefore, these should be used only on rehabilitation projects. When traditional closers are used, grade 1 should be specified if door is required to be under control from 125 degrees of door opening to the closed position.

Grade 1 closers should be considered for high frequency use doors, such as exterior doors and toilet room doors. Door closers should never be located on the exterior of a building. Grade 1 modern closers will provide 125-degree control. Series C01000 is applicable to rehabilitation projects.

Series C02000 modern closers with standard covers should normally be specified for administrative and assembly facilities and Series C02000 with full covers for health facilities when appearance is considered important and when option PT-4C (50 percent adjustable closing force) is required. Option PT-4C should be specified for exterior doors, vestibule doors, or other doors subject to strong wind or draft, and air conditioning effects, where considerable adjustment for proper operation may be necessary. Option PT-4D should be used on interior doors. When dealing with handicapped accessibility entrances, closer Series C02000 with option PT-4F, delayed action closing and option PT-4H, full spring adjustability should be specified.

Series C03000 should be specified for educational or housing facilities when appearance is considered of less importance.

Series C04000 and C05000 concealed closers are not generally recommended, but may be specified on main entrance doors of monumental type buildings, and other openings where concealment is necessary to complement the design of the building. Floor closers may be considered in lieu of series C04000 and C05000 closers.

In general, closer sizes should not be identified in the hardware sets because size will be determined by the Contractor. Closer sizes should be checked when the hardware schedule is submitted by the Contractor.
****

Surface type closers shall be Grade 1, Series [C01000 with options PT-4C and PT-4D] [C02000 Standard Cover] [C02000 Full Cover] [C03000] with options PT-4H, Size 1 or 2 through Size 6, and PT-4D with back check position valve. [Closers for screen and storm doors shall be Type C09353.] Except as otherwise specified, sizes shall conform to the manufacturer's published recommendations. Closers for outswinging exterior doors shall have parallel arms or shall be top jamb mounted. Closers for doors close to a wall shall be of narrow projection so as not to strike the wall at the 90-degree open position.

2.8.2   Floor Closers and Pivots

****

NOTE: Pivots may be considered for extra heavy doors such as lead-lined doors. Pivots that permit vertical adjustment are preferred. Center hung pivots are used on double acting doors and generally in connection with floor closers. Offset pivots and intermediate pivots are used on single acting doors.

Where floor closers are required, the structural drawings will be checked to ascertain that the floor slab design will not interfere with the installation of the floor closer cement case. If the floor finish is to be terrazzo, a floor pan will be specified. At exterior doors requiring a threshold, specify an integral access plate in the threshold. Spindle height for pivots may have to be increased for carpeted floors and access holes provided for screws attaching the access plate to the closer case if carpet is laminated to the access plate. Floor closers and pivots will generally be the following types:

Double acting - Type C06012. Single acting - Type CO6041.

Single acting for lead-lined doors - Type C06071 with Type C07311 offset intermediate pivots.

Offset intermediate pivots - Type C07321, used with Type C06041 or C06042 floor closers.

Single acting offset type floor pivots will be stainless steel or bronze as required to harmonize with the door trim.

****

Floor closers shall be Grade 1 with internal dead stop for all exterior doors. Floor closers shall have cement boxes. Pivots used on doors with floor closers shall be of the same manufacturer as the floor closers. Floor plates are not required where thresholds cover the closer cement box. Floor closers shall have independent latch and sweep speed adjusting valves, backcheck, mechanical selective hold-open (except fire rated openings), and optional delayed action. Setting tools shall be furnished for use in installing floor closers. Electric pivots and floor closers shall comply with BHMA A156.4 with modifications to ensure correct operation of electric hardware items.

2.9   DOOR CONTROLS - OVERHEAD HOLDERS

****

NOTE: Overhead holders are normally surface applied and required for exterior doors only, except where other types of holders are not suitable for interior doors. A hold-open device will never be used on a labeled door unless the hold-open function is released by a detector approved for labeled doors. Overhead concealed holders may be required for such interior doors as hospital patient rooms. Fusible-link closers will not be used on hospital or nursing facility patient rooms. When hold-open devices are used in conjunction with closers, a door stop is required.
****

Door controls - overhead holders shall conform to BHMA A156.8.

2.10 SMOKE DETECTORS AND ELECTRO-MAGNETIC HOLDERS

****
NOTE: Edit this paragraph according to the devices listed in paragraph HARDWARE SETS. Door holding devices shall be controlled by the building fire alarm system when a complete automatic fire detection system is provided. Door holding devices shall be controlled by ceiling mounted partial area or single station smoke detectors conforming to NFPA 72 or closers with integral detectors where a complete detection system is not required. Coordinate with the electrical designer to ensure that smoke detectors and power voltage are properly designed and specified.
****

[[Electro-magnetic door holders] [electro-mechanical door holders] [door closers with integral hold-open device] shall conform to BHMA A156.15 and shall release the door upon activation of [the building fire alarm system] [a ceiling mounted smoke detector] or interruption of electric power.] [Door closers with integral hold-open device and detector which senses visible and invisible particles of combustion shall conform to BHMA A156.15. The door shall be released upon activation of the detector or interruption of electric power.]

2.11 POWER ASSIST AND LOW ENERGY POWER OPERATORS

****
NOTE: Power assist or low energy power operators may be specified at high traffic entrances and other doors required to be accessible to persons with disabilities when static air pressures due to wind and/or ventilation system design requires a door opening force greater than 22 N (5 1bf) applied to the latch stile of the door.
****

Power assist and low energy power operators shall conform to BHMA A156.19 and shall be [electrically] [pneumatically] operated.

2.12   ARCHITECTURAL DOOR TRIM

****

NOTE: Stainless steel may be considered for medical facilities. Brass, bronze, and stainless steel may be considered in lieu of plastic in hospitals, monumental type buildings, or other buildings where appearance is particularly important.

****

Architectural door trim shall conform to BHMA A156.6.

2.12.1   Door Protection Plates

2.12.1.1   Armor Plates

Armor plates shall be Type [J105 plastic, [_____] in color,] [J101 [aluminum] [brass] [stainless steel],] 36 inches in height, and 2 inches less in width than the width of the door for single doors and 1 inch less for pairs of doors. Edges of metal plates shall be [square] [beveled]. Where the door has a louver panel, the armor plate shall be omitted if top of louver frame is more than 20 inches above the bottom of the door.

2.12.1.2   Kick Plates

****

NOTE: Metal kick plates, 400 mm (16 inches) high with beveled edges, shall be used on all doors required to be accessible to physically handicapped persons in accordance with the Uniform Federal Accessibility Standards. Stile and rail doors with the bottom rail less than 400 mm (16 inches) high shall have a smooth panel or kick plate 400 mm (16 inches) high. The panel or kick plate shall have sufficient strength to withstand the door opening force applied by a wheelchair footrest, walker, crutch or similar walking aid. Cavities created by panels or kickplates shall be capped. Kick plates shall be installed on the push side of the door or on both sides of a double acting door.

****

Kick plates shall be Type [J106 plastic, [_____] in color.] [J102 [aluminum] [brass] [stainless steel].] Width of plates shall be 2 inches less than door width for single doors and 1 inchless for pairs of doors. Height shall be [10] [12] [16] inches, except where the bottom rail is less than [10] [12] [16] inches the plate shall extend to within 1/2 inch of the panel mold or glass bead. Edges of metal plates shall be [square] [beveled].

2.12.1.3   Mop Plates

Mop plates shall be Type [J107 plastic [_____] in color.] [J103 [aluminum] [brass] [stainless steel].] Width of plates shall be 2 inches less than door width for single doors and 1 inchless for pairs of doors. The height shall be 4 inches.Edges of metal plates shall be [square] [beveled].

2.12.2 Door Edge Guards

****
NOTE: Refer to BJMA A156.6 for door edge Type selection.
****

Door edge guards shall be furnished to protect door edges with the required cut-outs for hardware items such as hinges, flush bolts, and locks. Door edge guards shall satisfy fire door ratings. Door edge guards shall be Type [_____] 0.50 inch thick [aluminum] [stainless steel].

2.12.3 Push Plates

2.12.3.1 Combination Push-Pull Plates

Combination push-pull plates shall be Type J303, 0.050 inchthick minimum [aluminum] [brass] [stainless steel] beveled four edges.

2.12.3.2 Flat Plates

Flat plates shall be [Type J301 0.50 inch thick] [aluminum] [brass] [bronze] [stainless steel] [Type J304 1/8 inch thick plastic, [_____] in color], size [_____]. Edges of metal plates shall be [square] [beveled].

2.12.4 Door Pulls and Push/Pull Units

2.12.4.1 Arm Pulls

Arm pulls shall be Category J400, double base, [aluminum] [brass] [stainless steel].

2.12.4.2 Drop Ring Pulls

Drop ring pulls shall be Type J404, [aluminum] [brass] [stainless steel].

2.12.4.3 Door Pulls

Door pulls shall be Category J400 [aluminum] [brass] [stainless steel] of plain modern design. Pulls for hollow metal, mineral core wood or kalamein doors shall be Type J405 thru-bolted to Type J301 flat push plates.

2.12.5 Push and Pull Bars

Push and pull bars shall be Category J500, [aluminum] [brass] [stainless steel]. Edges of mounting plates shall be [square] [beveled].

2.13 AUXILIARY HARDWARE

****
NOTE: Auxiliary hardware applicable to any door and illustrated in BHMA A156.16 will be listed in the text and type indicated in the respective hardware set. Other hardware required and illustrated in BHMA A156.16 not applicable to functioning of doors will be listed and type specified. Oak strips will be indicated on the drawings and as specified in

Section 06200 FINISH CARPENTRY for installation of robe hooks in rough usage areas. Lever extension flush bolts and dust-proof strikes will be used on the inactive leaf of pairs of doors required to be locked or latched, except dust-proof strikes will not be used on doors having metal thresholds. On industrial tubular-steel doors, locked interior doors where flush bolts are not feasible, and in less finished areas such as storage closets, mechanical rooms and closets, mechanical rooms and similar spaces, surface mounted, spring activated chain bolts and foot bolts will be used.
****

Auxiliary hardware, consisting of [_____] [door holders,] [door stops,] [and] [roller latches], shall conform to BHMA A156.16. [Lever extension flush bolts shall be Type L14081.] [Dust-proof strikes shall be Type L04011 for doors that are not fire rated. Dust-proof strikes shall be Type L04021 for fire rated doors.] Other auxiliary hardware of the types listed below, shall conform to BHMA A156.16.

Garment Hooks: [_____]	Garment Rods: [_____]
Hand Rail Brackets: [_____]	Coat Hook: [_____]

2.14 MISCELLANEOUS

2.14.1 Automatic Door Bottoms

Automatic door bottoms shall be [surface] [mortised] [semi-mortised] type with aluminum housing cover, [anodized clear] [anodized bronze color] finish. Door bottom shall have a wool, felt, rubber, vinyl, or neoprene seal and shall be actuated by the opening and closing of the door. The door bottom shall exclude light when the door is in the closed position and shall inhibit the flow of air through the unit.

2.14.2 Metal Thresholds

****
NOTE: Cast, forged, or extruded brass or bronze finish (Finish No. 1) should only be considered for monumental type buildings where appearance is important. Thresholds with stop strip are used on exterior reverse bevel doors as a weather stop and may be used for pairs of doors with vertical rod exit devices. Wet areas or chemical corrosive areas should have thresholds specified with a skid and corrosive-resistant type surface. Thresholds on rated fire assemblies should not be modified in the field.
****

Thresholds shall conform to BHMA A156.21. Thresholds for exterior doors shall be [extruded aluminum] [bronze] of the type indicated and shall provide proper clearance and an effective seal with specified weather stripping. [Thresholds for use with floor closers shall conform to BHMA A156.4.] [Latching thresholds shall be of such height that the bottom of the door shall be 1/8 inch over the tread of the threshold and 1/8 inch below the top of the stop.] [Where required, thresholds shall be modified to receive projecting bolts of [flush bolts] [exit devices].] [Thresholds for doors accessible to the handicapped shall be beveled with slopes not exceeding 1:2 and with heights not exceeding 1/2 inch.] [Air leakage rate of weatherstripping shall not exceed 0.5 cubic feet per minute per lineal foot of crack when tested in accordance with ASTM E 283 at standard test conditions.]

2.14.3 Rain Drips

Extruded aluminum, not less than 0.07 inch thick, [mill finished] [clear anodized] [bronze anodized] [painted]. Door sill rain drips shall be 1-1/2 inches to 1-3/4 inches high by 5/8 inch projection. Overhead rain drips shall be approximately 1-1/2 inches high by 2-1/2 inchesprojection and shall extend 2 inches on either side of the door opening width.

2.14.4 Aluminum Housed Type Weatherseals

Weatherseals of the type indicated shall consist of extruded aluminum retainers not less than 0.07 inch wall thickness with vinyl, neoprene, silicone rubber, polyurethane or vinyl brush inserts. Aluminum shall be [clear (natural)] [bronze] anodized. Weatherseal material shall be of an industrial/commercial grade. Seals shall remain functional through all weather and temperature conditions. Air leakage rate of weatherstripping shall not exceed 0.5 cubic feet per minute per lineal foot of crack when tested in accordance with ASTM E 283 at standard test conditions.

2.14.5 Gasketing

Gasketing shall be a compression type seal, silicon based, self-adhesive product for use on steel door frames with [wood] [steel] doors for [20-minute] [45 minute C-label] [1-hour B-label] [1-1/2 hour B-label]. Color shall be [white] [bronze]. Air leakage rate of weatherstripping shall not exceed 0.5 cubic feet per minute per lineal foot of crack when tested in accordance with ASTM E 283 at standard test conditions.

2.14.6 Key Control Storage System

Key control storage system shall conform to BHMA A156.5, Type [_____], capacity [_____], and shall be properly labeled for key identification. Set up, identification labeling and location of the key control storage shall be as directed at the Predelivery Conference.

2.14.7 Door Stops

****

NOTE: The use of adjustable hinge pin type door stops (ANSI/BHMA A156.16, type L02223) is prohibited because they impose destructive stresses on doors, door fames, hinges and hinge screws.

****

Wall stops, floor stops and combination stop and holders shall conform to BHMA A156.16.

2.15 FASTENINGS

Fastenings of proper type, size, quantity, and finish shall be supplied with each article of hardware. Machine screws and expansion shields shall be used for attaching hardware to concrete or masonry. Fastenings exposed to the weather in the finished work shall be of brass, bronze, or stainless steel. Sex bolts, through bolts, or machine screws and grommet nuts, where used on reverse-bevel exterior doors equipped with half-surface or full-surface hinges, shall employ one-way screws or other approved tamperproof screws. Screws for the jamb leaf of half-mortise and full-surface hinges attached to structural steel frames shall be one-way or other approved tamperproof type.

2.16 FINISHES

****

NOTE: Choose BHMA code and show finish in hardware schedule for hardware sets. Finish 600 (primed) hinges should generally be used for interior doors, or for inswinging exterior doors where corrosion is not a problem. Plated steel (finish 639 or 652) finishes should be considered for hinges in lieu of finish 600 for natural finish wood doors, or doors in areas where aesthetics are particularly important, such as special and publicly exposed facilities (i.e. clubs, hospital-clinics, conference rooms, etc.). Finishes should be compatible with other hardware and the decor of the building. Mixing finishes should be avoided whenever possible. The base metal of any item specified should agree with the finish symbol.

Hinges for aluminum doors should generally be finish 626 or 630, and should never be a base metal of aluminum.

Finishes 612 or 630 should be considered for outswinging exterior doors in lieu of finish 600 where corrosion may be a problem.

Lock and door trim finishes will generally be the following types:

Aluminum doors - 626 or 630.
Main entrance doors - 612, 626, or 630.
Other doors - 612, 626, 630, 639, or 652.
Door closers - 600, 689, 690, 691, or 692.

****

Unless otherwise specified, finishes shall conform to those identified in BHMA A156.18. Where painting of primed surfaces is required, painting is specified in Section 09900 PAINTING, GENERAL.

2.17 HARDWARE FOR FIRE DOORS

Hardware for fire doors shall conform to the requirements of NFPA 80and NFPA 101.

PART 3 EXECUTION

3.1 APPLICATION

Hardware shall be located in accordance with DHI Locations for CSD and DHI Locations for SSD, except that deadlocks shall be mounted 48 inches above finish floor. When approved, slight variations in locations or dimensions will be permitted. Application shall be in accordance with DHI ANSI/DHI A115.1G or DHI ANSI/DHI A115-W. Door control devices for exterior doors such as closers and holders, shall be attached to doors with thru bolts and nuts or sex bolts. Alternate fastening methods may be approved by the Contracting Officer when manufacturers' documentation is submitted to verify that the fastening devices and door reinforcements are adequate to resist wind induced stresses. Electric hardware items and access control devices shall be installed in accordance with manufacturer's printed installation procedures.

3.1.1 Hardware for Fire Doors and Smoke-Control Door Assemblies

Hardware for fire doors shall be installed in accordance with the requirements of NFPA 80. Exit devices installed on fire doors shall have a visible label bearing the marking "Fire Exit Hardware". Other hardware installed on fire doors, such as locksets, closers, and hinges shall have a visible label or stamp indicating that the hardware items have been approved by an approved testing agency for installation on fire-rated doors. Hardware for smoke-control door assemblies shall be installed in accordance with NFPA 105.

3.1.2 Door-Closing Devices

Door-closing devices shall be installed and adjusted in accordance with the templates and printed instructions supplied by the manufacturer of the devices. Insofar as practicable, doors opening to or from halls and corridors shall have the closer mounted on the room side of the door.

3.1.3 Key Control Storage Systems

Key control storage system shall be [installed where directed] [furnished to the Contracting Officer].

3.1.4 Kick Plates and Mop Plates

Kick plates shall be installed on the push side of single-acting doors and on both sides of double-acting doors. Mop plates shall be installed on the pull side of the single acting doors.

3.1.5 Auxiliary Hardware

Lever extension flush bolts shall be installed at the top and bottom of the inactive leaf of pairs of doors. The bottom bolt shall operate into a dust-proof floor strike or threshold.

3.1.6 Thresholds

Thresholds shall be secured with a minimum of three fasteners per single door width and six fasteners per double door width with a maximum spacing of 12 inches. Exterior thresholds shall be installed in a bed of sealant with expansion anchors and stainless steel screws, except that bronze or anodized bronze thresholds shall be installed with expansion anchors with brass screws. Minimum screw size shall be No. 10 length, dependent on job conditions, with a minimum of 3/4 inchthread engagement into the floor or anchoring device used.

3.1.7 Rain Drips

Door sill rain drips shall align with the bottom edge of the door. Overhead rain drips shall align with bottom edge of door frame rabbet. Drips shall be set in sealant and fastened with stainless steel screws.

3.1.8 Weatherseals

Weatherseals shall be located as indicated, snug to door face and fastened in place with color matched metal screws after door and frames have been finish painted. Screw spacing shall be as recommended by manufacturer.

3.1.9 Gasketing

Gasketing shall be installed at the inside edge of the hinge and head and latch sides of door frame. Frames shall be toleranced for a 1/8 inch clearance between door and frame. Frames shall be treated with tape primer prior to installation.

3.2 OPERATIONAL TESTS

Prior to acceptance of any electrical hardware system, an operational test shall be performed to determine if devices are operating as intended by the specifications. Wiring shall be tested for correct voltage, current carrying capacity, and proper grounding. Stray voltages in lock wiring shall be eliminated to prevent locking devices from releasing in critical situations.

3.3 FIELD QUALITY CONTROL

****

NOTE: Verify the availability of an Architectural Hardware Consultant to perform the following inspection. The hardware supplier may be required to perform the field quality control inspection when an AHC is not available. This paragraph may be deleted for very small projects where there are no unusual complexities in the hardware requirements.

****

[Architectural Hardware Consultant] [Supplier] shall inspect the completed installation and certify that the hardware has been furnished and installed in accordance with the manufacturers' instructions [and as specified]. The inspection report shall identify any malfunctioning items and recommend adjustment or replacement as appropriate.

3.4 HARDWARE SETS

****

NOTE: Hardware Sets: The following example is a suitable form for the hardware sets. Refer to paragraph FINISHES and add BHMA finish codes. Hardware sets will be identified to proper doors on the drawings.

Where Government furnished lock cylinders are specified in paragraph Lock Cylinders (Mortise, Rim and Bored), all required cylinders will be listed in the HW-sets and identified as FGE to assure that all bidders include only the cylinder installation cost in their proposals. Coordination with InstaKey Lock Corporation through the using agency and GSA or DISC is necessary during preparation of HW-sets to assure that the GFE package will be compatible with contractor furnished hardware items.

Hardware items listed in the hardware sets shall be selected to conform with accessibility requirements of the Uniform Federal Accessibility Standards (UFAS) and 36 CFR 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities except for facilities where accessibility requirements are specifically exempted.

HW-1	**3 pr.**	**Hinges, A8112**
	1 ea.	**Lockset, F17 - Grade 2**
	2 ea.	**Pulls, J400**
	2 ea.	**Push Plates, J300**
	2 ea.	**Flush Bolts, L34081**
	2 ea.	**Closers, C00321**
	2 ea.	**Kick Plates, J102**
	2 ea.	**Stops, L31371**
	1 ea.	**Threshold, J603**
HW-2	**1-1/2 pr.**	**Hinges, A1111**
	1 ea.	**Exit Device, Type 2, Function 08-Grade 1**
	1 ea.	**Closer, C02021**
	1 ea.	**Kick Plate, J102**
	1 ea.	**Stop, L31371**
	1 ea.	**Threshold, J603**
HW-3	**1-1/2 pr.**	**Hinges, A8112**
	1 ea.	**Lockset, F07 - Grade 1**
	1 ea.	**Closer, C02021**
	1 ea.	**Kick Plate, J102**
	1 ea.	**Stop, L02101 with toggle bolt.**

****

HW-1 [_____]
HW-2 [_____]
HW-3 [_____]

-- End of Section --

****

DEPARTMENT OF THE ARMY **CEGS-08810 (May 1997)**
U.S. ARMY CORPS OF ENGINEERS **--------------------------**
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-- End of Section Table of Contents --

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SECTION 08810

GLASS AND GLAZING
05/97

****

NOTE: This guide specification covers the requirements for flat glass; annealed, heat-absorbing, light-reducing, patterned, wired, architectural laminated, solar-reflective, low-E, tempered, heat-strengthened, spandrels, fire/safety rated, mirrors, and control tower glass. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for laminated glass, spandrel glass, fire/safety rated glass, mirrors, and control tower glass. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****
NOTE: The Corps of Engineers, ARCHITECTURAL AND ENGINEERING INSTRUCTIONS (AEI), DESIGN CRITERIA, should be reviewed to determine the requirements of glazing.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(1984; R 1994) Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 509	(1994) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C 669	(1995) Glazing Compounds for Back Bedding and Face Glazing of Metal Sash
ASTM C 864	(1998) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 1036	(1991; R 1997) Flat Glass
ASTM C 1048	(1997b) Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass
ASTM C 1172	(1996) Laminated Architectural Flat Glass
ASTM C 1349	(1996) Architectural Flat Glass Clad Polycarbonate
ASTM D 395	(1989; R 1994) Rubber Property - Compression Set
ASTM E 119	(1998) Fire Tests of Building Construction and Materials
ASTM E 773	(1997) Accelerated Weathering of Sealed

	Insulating Glass Units
ASTM E 774	(1997) Classification of the Durability of Sealed Insulating Glass Units
ASTM E 1300	(1998) Determining the Minimum Thickness and Type of Glass Required to Resist a Specified Load

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1995) Minimum Design Loads for Buildings and Other Structures

CODE OF FEDERAL REGULATIONS (CFR)

16 CFR 1201	Safety Standard for Architectural Glazing Materials

COMMERCIAL ITEM DESCRIPTION (CID)

CID A-A-378	(Basic) Putty Linseed Oil Type, (for Wood-Sash-Glazing)

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(1997) Glazing Manual
GANA Standards Manual	(1995) Engineering Standards Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1999) Fire Doors and Fire Windows
NFPA 252	(1995) Fire Tests of Door Assemblies
NFPA 257	(1996) Fire Tests for Window and Glass Block Assemblies

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Glass; [_____]. Glazing Accessories; [_____].

Manufacturer's descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions.

SD-04 Drawings

Glazing Materials and Accessories; [_____].

Drawings showing complete details of the proposed setting methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of glass.

Control Tower Glazing Units; [_____].

Drawing showing complete details of the proposed setting methods and materials.

SD-13 Certificates

Glass; [_____].

Certificates stating that the glass meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

Control Tower Glazing Units; [_____].

Certificates from the manufacturer attesting that the units meet the luminous and solar radiant transmission requirements for heat absorbing glass.

SD-14 Samples

Glass; [_____].

Two 8 x 10 inch samples of each of the following: tinted glass, patterned glass, heat-absorbing glass, [_____] and insulating glass units.

1.3 SYSTEM DESCRIPTION

Glazing systems shall be fabricated and installed watertight and airtight to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, and defects in the work. Glazed panels shall comply with the safety standards, as indicated in accordance with ANSI Z97.1. Glazed panels shall comply with indicated wind/snow loading in accordance with ASTM E 1300.

1.4 DELIVERY, STORAGE AND HANDLING

Glazing compounds shall be delivered to the site in the manufacturer's unopened containers. Glass shall be stored indoors in a safe, well ventilated dry location in accordance with manufacturer's instructions, and shall not be unpacked until needed for installation. Glass shall not be stored on site over 1 month.

1.5 PROJECT/SITE CONDITIONS

Glazing work shall not be started until outdoor temperature is above 40 degrees F and rising, unless procedures recommended by glass manufacturer and approved by Contracting Officer are made to warm the glass and rabbet surfaces. Ventilation shall be provided to prevent condensation of moisture on glazing work during installation. Glazing work shall not be performed during damp or raining weather.

1.6 WARRANTY

****

NOTE: Add or delete warranty requirements as required to meet project requirements.

****

1.6.1 Insulating Glass

Manufacturer shall warrant the insulating glass to be free of fogging or film formation on the internal glass surfaces caused by failure of the hermetic seal for a period of 10 years from Date of Substantial Completion. Warranty shall be signed by manufacturer.

1.6.2 Monolithic Reflective Glass

Manufacturer shall warrant the monolithic reflective glass to be free of peeling or deteriorating of coating for a period of 10 years after Date of Substantial Completion. Warranty shall be signed by manufacturer.

1.6.3 Monolithic Opacified Spandrel

Manufacturer shall warrant the opacifier film on the spandrel to be free of peeling for a period of five years after Date of Substantial Completion. Warranty shall be signed by manufacturer.

1.6.4 Control Tower Insulating Glass

Manufacturer shall warrant the control tower insulating glass to be free of fogging or film formation on the internal glass surfaces for a period of one year from Date of Substantial Completion. Warranty shall be signed by manufacturer.

PART 2 PRODUCTS

****

NOTE: Locations and types of all glass, size of glazed openings, and frame details indicating method of glazing shall be shown on drawings. Glass thickness shall be shown on drawings.

It is critical that skylights be maintainable. Designer must include skylight access devices as a part of the design package where skylights are large or at great heights above floor.

Glazed openings other than glazed panels that are located in areas subject to accidental human impact shall be glazed with safety glass conforming to 16 CFR 1201, SAFETY STANDARD FOR ARCHITECTURAL GLAZING

MATERIALS. Within the context of this specification, 16 CFR 1201 establishes two categories of products as follows:

1. Category I Products: Doors and glazed panels that contain single piece of glazing material no greater than 0.84 m2 (9 ft2) in area. The product must be capable of withstanding 203 Nm (150 foot pound) impact load test.

2. Category II Products: Doors and glazed panels that contain any single piece of glazing material greater than 0.84 m2 (9 ft2) in area. The product must be capable of withstanding a 542 Nm (400-foot-pound) impact load test. Category II products may be used in both Category I and Category II situations.

3. Doors: 16 CFR 1201 applies to all types of interior doors and exterior doors, including storm doors and combination doors. Safety glass is not required for openings in doors through which a 76 mm (3 inch) diameter sphere is unable to pass. Glazing for fire doors shall be in accordance with NFPA 80, even though this may be at variance with requirements of 16 CFR 1201.

4. Glazed Panels: 16 CFR 1201 no longer applies to exterior and interior glazed panels. Glazed panels shall conform to ANSI Z97.1, SAFETY PERFORMANCE SPECIFICATION AND METHODS OF TEST FOR SAFETY GLAZING MATERIALS USED IN BUILDINGS. Since glazed panels may be hazardous, safety glazing should be generally provided as described below:

a) Glazed panels of any size located adjacent to a doorway, with the nearest vertical edge of panel within 1219 mm (48 inches) of doorway, and with bottom edge of panel below top of door. Safety glazing is not required for panels separated from the doorway by an intervening interior permanent wall.

b) Glazed panels with a surface area greater than 0.84 m2 (9 ft2) where there is a walking surface on either side of panel, and the walking surface is within 914 mm (36 inches) of the panel. Safety glazing is not required if the lowest edge of the glazing material is 457 mm (18 inches) or more above both walking surfaces, or if the panels have a horizontal member, such as a mullion or permanent railing not less than 38 mm (1-1/2 inches) in width, capable of withstanding a horizontal load of 75 kg/m (50 plf), on the accessible sides of the glazing and located between 609 mm and 914 mm (24 and 36 inches) above the walking surface.

c) Where insulating glass units are used in locations requiring safety glazing, both panes shall be safety glass.

d) For exterior applications, safety glazing must also meet the wind and snow load requirements in accordance with ASTM E 1300.

e) In general, any glazed area subject to human impact should be provided with safety glazing or other acceptable protective devices such as handrails or horizontal mullions.

ASTM C 1036 covers the quality requirements for clear annealed glass, transparent tinted heat-absorbing and light-reducing glass, patterned and wired glass with a series of classification designations such as Types, Classes, Styles, Forms, Qualities, Finishes, and Intended Uses, as defined below:

1. Type designations are: Type 1 - Transparent Flat Glass; Type II - Patterned and Wired Glass.

2. Class designations are: Class 1-clear; Class 2-tinted Heat-Absorbing and Light-Reducing; Class 3-tinted, light-reducing.

3. Style designations are: Style A - Higher light transmittance; Style B - Lower light transmittance.

4. Form designations are: Form 1 - Wired polished both sides; Form 2 - Patterned and wired, Form 3 - Patterned.

5. Quality designations including intended uses for ASTM C 1036 transparent flat glass are:

a) Quality q1 - Mirror Select Quality: Coated for premium mirrors.

b) Quality q2 - Mirror: Coated for general use mirrors.

c) Quality q3 - Glazing Select: For architectural fenestrations or other applications where distant objects are viewed through the glass by the observer.

6. Quality designations and intended uses for Patterned and Wired Flat Glasses:

a) Quality q7 - Decorative: For use where design and aesthetic characteristics are major considerations.

b) Quality q8 - Glazing: For general glazing where functional or aesthetic characteristics are a consideration and where surface blemishes are not a major concern.

c) Wired Glass: For skylights and general glazing where fire retardation or glass retention in a frame are a consideration.
****

2.1 FLOAT GLASS

2.1.1 Annealed Glass

****
NOTE: Annealed glass is used for general glazing where clear or tinted glass is required. Glass thickness shall be shown on drawings. Under some heavy thermal conditions, tinted glass may require heat strengthening for thermal endurance.
****

Annealed glass shall be Type I transparent flat type, Class 1 - [clear] [tinted], Quality q3 - glazing select, [_____] percent light transmittance, [_____] percent shading coefficient, conforming to ASTM C 1036. Color shall be [[gray] [bronze] [_____]] [as shown in Section 09915 COLOR SCHEDULE].

2.1.2 Heat-Absorbing Glass

****
NOTE: Heat-absorbing and light-absorbing glass may be used in accordance with AEI, DESIGN CRITERIA. Tinted (light-reducing) glass may be used where glare is a problem and a reduction of visible light transmission is desired. Visible light transmittance will vary from 15 to 85 percent, depending on color density and thickness. Color density is a function of thickness and increases as the thickness increases; visible light transmittance will decrease as thickness increases. ASTM C 1036 separates Heat-Absorbing and Tinted (light-reducing) glasses into categories, Higher light transmittance, and Lower light transmittance, which is based on the maximum solar energy transmittance by glass thickness.

Refer to ASTM C 1036 for evaluation quality requirements and glass manufacturer's data for color selection, light transmittance and shading coefficient. When specifying performance and color,

the available ranges of performance and colors should be specified for glazing units to allow several manufacturer's to bid. When matching existing glass, provide existing manufacturer's name, color and acceptable range for shading factor, light transmittance, indoor and outdoor reflectance.

Heat-absorbing and light-reducing glass is affected by thermal stresses which can result in breakage. Care should be taken to make sure that the glass units will not be thermally overburdened. Glass that will be thermally overburdened should be Heat-Strengthened or, if safety glazing is required, Fully Tempered to resist thermal breakage. Refer to ASTM C 1048 for quality evaluation and refer to manufacturer's data for performance and color selection.

Factors which increase the risk of breakage include building orientation, unusual shapes of lites, large lites, indoor shading devices, heating registers, and outdoor shading by trees, structure of exterior shading devices.

****

Heat-absorbing glass shall be Type I transparent flat type, Class 2-tinted, Quality q3 - glazing select, [_____] percent light transmittance, [_____] percent shading coefficient, conforming to ASTM C 1036. Color shall be [[gray] [bronze] [_____]] [as shown in Section 09915 COLOR SCHEDULE].

2.1.3 Tinted (Light-Reducing) Glass

Tinted (light-reducing) glass shall be Type I transparent flat type, Class 3-tinted, Quality q3 - glazing select, [_____] percent light transmittance, [_____] percent shading coefficient, conforming to ASTM C 1036. Color shall be [[gray] [bronze] [_____]] [as shown in Section 09915 COLOR SCHEDULE].

2.2 ROLLED GLASS

2.2.1 Patterned Glass

****

NOTE: Types of patterned glass available are wired patterned glass, patterned glass without wire mesh and tinted patterned glass. Patterned glass is available in various thicknesses, with a pattern embossed on one or both sides. This glass is frequently called "figured", "obscure", or "decorative" glass. The degree of diffusion achieved is a function of the pattern and whether the pattern is on one or both sides. Some patterned glass cannot be heat-strengthened or tempered because of the pattern depth.

Patterned glass is normally provided for windows of

toilet rooms, borrowed light sash at entrances, etc. Pattern glass does not offer complete obscurity and must be used with caution in very private areas such as toilets. The appropriate pattern designation should be selected from ASTM C 1036. If a more specific pattern designation is desired, a manufacturer's name and pattern may be specified. When specific manufacturer's names and patterns are specified, the designer should add the following note to the spec: "Manufacturer's name and patterns indicated are for identification purposes only; the listing is not intended to limit selection of similar patterns from other manufacturers." Where appearance is a primary consideration, patterned glass may be specified in Glazing Quality q7 - Decorative (having a more precise and refined pattern), and in Finish f2 - patterned both sides. Refer to GANA GLAZING MANUAL, and glass manufacturer's performance tables for proper evaluation of patterned glass thickness and size of opening to be glazed.

****

Patterned glass shall be Type II flat type. Class [1 - translucent] [2 - tinted heat absorbing] [3 - tinted heat reducing], Finish [f1 - patterned one side] [f2 - patterned both sides], Quality [q7 - decorative] [q8 - glazing], [_____] percent light transmittance, [_____] percent shading coefficient, conforming to ASTM C 1036. Color shall be [_____] [as shown in Section 09915 COLOR SCHEDULE].

2.2.2 Wired Glass

****

NOTE: Types of wired glass available are polished, patterned, and tinted/heat-absorbing wired glass. Wired glass cannot be tempered. Wired Glass does not meet the requirements of 16 CFR 1201 and cannot be used as safety glazing materials in situations governed by that regulation.

Typically 6 mm (1/4 inch) thick wired glass is used for fire-rated windows and doors where required by building codes and other fire-protection criteria.

Only wire glass in Mesh 1 - Diamond and Mesh 2 - Square are acceptable for fire rated door and window openings. Mesh 3 - Parallel is not acceptable for fire rated openings.

Wired glass, because of the wire mesh and edge damage from cutting, is very susceptible to thermal breakage. Heat absorbing wired glass increases the tendency for breakage. Wired glass is also susceptible to edge breakage from water penetrating the capillary in which the wires reside. The

glazing system should insure that the edges are kept dry by sealing the edges with silicone.
****

Wired glass shall be Type II flat type, Class [1 - translucent] [2 - tinted, heat-absorbing] [3 - tinted, light-reducing], Quality [q7 - decorative] [q8 - glazing], Form [1 - wired and polished both sides] [2 - patterned and wired], [_____] percent light transmittance, [_____] percent shading coefficient, conforming to ASTM C 1036. Wire mesh shall be polished stainless steel Mesh [1 - diamond] [2 - square] [3 - parallel]. Wired glass for fire-rated windows shall bear an identifying UL label or the label of a nationally recognized testing agency, and shall be rated for [20] [45] minutes when tested in accordance with NFPA 257. Wired glass for fire-rated doors shall be tested as part of a door assembly in accordance with NFPA 252. Color shall be [_____] [as shown in Section 09915 COLOR SCHEDULE].

2.3 INSULATING GLASS

****
NOTE: Insulating glass units may be used when authorized by the AEI design criteria to reduce heat loss or heat gain through the glass. Refer to GANA GLAZING MANUAL, Insulating Glass Performance Tables, for proper selection of glass performance and color.
****

Insulating glass shall be Class A preassembled units of dual-seal construction consisting of lites of glass separated by an aluminum, steel, or stainless steel, spacer and dehydrated space conforming to ASTM E 773 and ASTM E 774. Spacer shall be roll-formed, with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal shall be compressed polyisobutylene and the secondary seal shall be a specially formulated silicone. Glass types shall be as follows:

2.3.1 Clear Insulating Glass

Glass for [two-pane] [three-pane] insulating units shall be Type I annealed glass, Class 1 - clear, Quality q3 - glazing select, conforming to ASTM C 1036. Glass performance shall be R-Value/Winter Nighttime [_____].

2.3.2 Heat-Absorbing Insulating Glass

****
NOTE: Heat-absorbing insulating glass is affected by thermal stresses which can result in breakage. Care should be taken to make sure that the glass units will not be thermally overburdened. Refer to ASTM C 1048 for quality evaluation and refer to manufacturer's data for performance and color selection.

Factors which increase the risk of breakage include building orientation, unusual shapes of lites, large lites, indoor shading devices, heating registers,

and outdoor shading by trees, structure of exterior shading devices.
****

Interior and exterior glass panes for heat-absorbing insulating units shall be Type I annealed flat glass, Class 2-tinted, Quality q3 - glazing select, conforming with ASTM C 1036. Glass performance shall be R-Value/Winter Nighttime [_____],shading coefficient [_____]. Color shall be [[silver] [_____]] [as shown in Section 09915 COLOR SCHEDULE].

2.3.3 Reflective Insulating Glass

****
NOTE: The two basic types of reflective glass are Solar-Reflective and Low-Emissivity (Low-E). The major differences are visible light transmission, wavelengths of energy that are reflected, and the direction in which these wavelengths are usually reflected. Solar-Reflective Glass has a mirror-like coating that is highly reflective of solar energy. Low-E Glass has a metal or metallic-oxide coating that is nearly invisible to the eye.

Low-Emissivity (Low-E) glass reduces energy costs by creating a heat barrier that helps keep heat outside in the summer and inside in the winter. Low-E glass is suitable for all climates and is available for use in double and triple insulating glass units. Insulating units with an outer panel of tinted or reflective glass can provide added energy cost efficiencies. Refer to manufacturer's data to evaluate shading coefficient and relative heat gain.
****

Interior and exterior glass panes for reflective insulating units shall be Type I annealed flat glass, Class 2-tinted, Quality q3 - glazing select, conforming to ASTM C 1036. Glass performance shall be R-Value/Winter Nighttime [_____], shading coefficient [_____]. Color shall be [[silver] [silver green] [silver gray] [royal blue] [_____]] [as shown in Section 09915 COLOR SCHEDULE].

2.3.4 Low-E Insulating Glass

****
NOTE: Coordinate with paragraph Reflective Insulating Glass.
****

Interior and exterior glass panes for Low-E insulating units shall be Type I annealed flat glass, Class [1-clear] [2-tinted] with anti-reflective low-emissivity coating on No. 2 surface (inside surface of exterior pane), Quality q3 - glazing select, conforming to ASTM C 1036. Glass performance shall be R-Value/Winter Nighttime [_____], shading coefficient [_____]. Color shall be [[green] [gray] [bronze] [blue] [_____]] [as shown in Section 09915 COLOR SCHEDULE].

2.4 REFLECTIVE GLASS

****
NOTE: Coordinate with paragraph Reflective Insulating Glass.
****

Reflective glass shall conform to the following requirements.

2.4.1 Solar-Reflective Glass

Solar-reflective glass shall be Type I annealed flat type, Class 2-tinted glass with a mirror-like metallic or metallic-oxide highly reflective surface, Quality q3 - glazing select, conforming to ASTM C 1036. Glass performance shall be R-Value/Winter Nighttime [_____], shading coefficient [_____]. Color shall be [[silver] [bronze] [_____]] [as shown in Section 09915 COLOR SCHEDULE].

2.4.2 Low-Emissivity (Low-E) Glass

Low-emissivity (Low-E) glass shall be Type I annealed flat type, Class 2-tinted with low-emissivity coating on No. 2 surface (inside surface of exterior pane), Quality q3 - glazing select. Glass performance shall be R-Value/Winter Nighttime [_____], shading coefficient [_____]. Color shall be [[green] [gray] [bronze] [blue] [_____]] [as shown in Section 09915 COLOR SCHEDULE].

2.5 HEAT-TREATED GLASS

****
NOTE: ASTM C 1048 covers the quality requirements for flat heat-strengthened, flat fully tempered coated and uncoated glass with a series of classification designations such as Kinds, Conditions, Types, Classes, Styles, Forms, Qualities, Finishes and Intended Uses defined as follows:

1. Kind HS, Types I and II: Heat-strengthened glass for general glazing where additional strength is desired but not requiring the strength of fully tempered glass.

2. Kind FT, Types I and II: Fully tempered glass for general glazing and safety glazing such as sliding doors, storm doors, building entrances, bath and shower enclosures, counter tops, showcases, interior partitions, and other uses where superior strength characteristics and safety properties of fully tempered glass are required.
****

Heat-treated glass shall conform to the following requirements.

2.5.1 Tempered Glass

****
NOTE: Tempered glass may be used where safety glass

is required by 16 CFR 1201. Tempered Glass meeting ASTM C 1048 must also meet ANSI Z97.1 requirements to qualify as a safety glazing material. Refer to ASTM C 1048 to establish classification and quality of glass, and refer to manufacturer's data for performance evaluation and color selection. Tempered glass is available in thicknesses 3 mm to 19 mm (1/8 to 3/4 inch).

****

Tempered glass shall be kind FT fully tempered transparent flat type, Class [1-clear] [2-tinted], Condition A uncoated surface, Quality q3 - glazing select, [_____] percent light transmittance, [_____] percent shading coefficient conforming to ASTM C 1048 and GANA Standards Manual. Color shall be [[clear] [bronze] [gray] [_____]] [as shown in Section 09915 COLOR SCHEDULE].

2.5.2   Heat-Strengthened Glass

****

NOTE: Heat-strengthened glass may be used for facilities with spandrels, atriums, solariums, skylights and where climates and/or shading may require the glass to be heat-strengthened. Heat-strengthened glass is not a safety glazing material and should not be used where human impact is a concern or where codes require safety glazing. Heat-strengthened glass can be made suitable for safety glazing applications by laminating.

****

Heat-strengthened glass shall be kind HS heat-strengthened transparent flat type, Class [1-clear] [2-tinted], Condition A uncoated surface, Quality q3 - glazing select, conforming to ASTM C 1048. Color shall be [[clear] [bronze] [gray] [_____]] [as shown in Section 09915 COLOR SCHEDULE].

2.6   LAMINATED GLAZINGS

2.6.1   Laminated Glass

****

NOTE: Laminated glass can be fabricated of two or more pieces of glass, and one or more interlayers of plastic. Annealed, heat-treated, wired, tinted and reflective glass, one-way and two-way mirrors can be incorporated into laminated units. Laminated glass may be used as safety glazing material or may be used to improve acoustics of a building. The designer should consider loading and safety requirements when choosing types of glass used.

****

Laminated glass shall consist of [two] [_____] layers of [Type I transparent float] [_____] glass, Class [1-clear] [2-tinted] Quality q3 - glazing select, conforming to ASTM C 1036. Glass shall be bonded together with [0.015] [0.030] [0.060] inchthick PVB interlayer under pressure, or alternatives such as resin laminates, conforming to requirements of 16 CFR 1201 and ASTM C 1172. Color shall be [[clear] [gray] [bronze] [_____]] [as shown in Section 09915 COLOR SCHEDULE].

2.6.2 Glass Clad Polycarbonate Laminates

****

NOTE: Glass clad polycarbonate laminates can be fabricated of one or more pieces of glass bonded with an aliphatic urethane interlayer to one or more sheets of extruded polycarbonate. Annealed, heat-strengthened, tempered, wired, tinted, and reflective glass, one-way and two-way mirrors can be incorporated into the glass clad polycarbonate units. Glass clad polycarbonates are used to improve the security of a building. The designer should consider the specific threat scenario when choosing the type of glass clad polycarbonate to be used.

****

Glass clad polycarbonate laminates shall consist of [two] [_____] layers of [Type I transparent float] [_____] glass, Class [1-clear] [2-tinted], Quality q3 - glazing select, conforming to ASTM C 1036 and [one] [_____] layer(s) of [0.118] [0.236] [0.375] inchthick [standard] [coated mar resistant] UV stabilized polycarbonate. Glass and polycarbonate shall be bonded together with [0.025] [0.050] inch thick clear polyurethane interlayers under pressure. The laminate shall conform to ASTM C 1349.

2.7 SPANDREL GLASS

2.7.1 Ceramic-Opacified Spandrel Glass

Ceramic-opacified spandrel glass shall be kind HS heat-strengthened transparent flat type, Condition B, coated with a colored ceramic material on No. 2 surface, Quality q3 - glazing select, conforming to ASTM C 1048. Glass performance shall be R-Value/Winter Nighttime [_____], shading coefficient [_____]. Color shall be [_____] [as shown in Section 09915 COLOR SCHEDULE].

2.7.2 Film-Opacified Spandrel Glass

Film-opacified spandrel glass shall be kind HS heat-strengthened transparent flat type, Quality q3 - glazing select, Condition C glass with a polyester or polyethylene film 2 mils to 5 mils thick attached to No. 2 surface of a sputtered solar-reflective film, conforming to ASTM C 1048. Film opacification shall be compatible to and specifically developed for application to solar reflective films. Glass performance shall be R-Value/Winter Nighttime [_____], shading coefficient [_____]. Color shall be [_____] [as shown in Section 09915 COLOR SCHEDULE].

2.8 FIRE/SAFETY RATED GLASS

Fire/safety rated glass shall be laminated Type I transparent flat type, Class 1-clear. Glass shall have a [20] [45] [60] [_____] minute rating when tested in accordance with ASTM E 119. Glass shall be permanently labeled with appropriate markings.

2.9 MIRRORS

****

NOTE: Select the frames (J-Mold channels) or clips to secure mirror to wall. Mastic is required with each type of installation. Mirror sizes will be shown on the drawings. Coordinate with Section 05500 MISCELLANEOUS METAL and Section 10800 TOILET ACCESSORIES to ensure that frames are specified for these mirrors.

One-way vision glass should be used for psychiatric and security observation windows. Where safety glazing is required, specify either laminated glass or tempered glass.

****

2.9.1 Glass Mirrors

Glass for mirrors shall be Type I transparent flat type, Class [1-clear] [2-tinted], Glazing Quality q1 1/4 inch thick conforming to ASTM C 1036. Glass color shall be [[clear] [bronze] [gray] [_____]] [as shown in Section 09915 COLOR SCHEDULE]. Glass shall be coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating shall be highly adhesive pure silver coating of a thickness which shall provide reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass, and shall be free of pinholes or other defects. Copper protective coating shall be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and shall be of proper thickness to prevent "adhesion pull" by mirror backing paint. Mirror backing paint shall consist of two coats of special scratch and abrasion-resistant paint , and shall be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

2.9.2 One-Way Mirrors

Glass for one-way mirrors shall be Type I transparent flat type, Class 1 clear, Glazing Quality q1, 1/4 inch thick conforming to ASTM C 1036. Glass shall be coated on one face with a hard adherent film of chromium or other approved coating of proven equivalent durability. Glass shall transmit not less than 5 percent nor more than 11 percent of total incident light in visible region, and shall reflect from front surface of coating not less than 45 percent of total incident light in visible region.

2.9.3 Mirror Accessories

2.9.3.1 Mastic

Mastic for setting mirrors shall be a [polymer] [_____] type mirror mastic resistant to water, shock, cracking, vibration and thermal expansion. Mastic shall be compatible with mirror backing paint, and shall be approved by mirror manufacturer.

2.9.3.2 Mirror Frames

Mirrors shall be provided with mirror frames (J-mold channels) fabricated of one-piece roll-formed Type 304 stainless steel with No. 4 brushed satin finish and concealed fasteners which will keep mirrors snug to wall. Frames shall be 1-1/4 x 1/4 x 1/4 inch continuous at top and bottom of mirrors. Concealed fasteners of type to suit wall construction material shall be provided with mirror frames.

2.9.3.3 Mirror Clips

Concealed fasteners of type to suit wall construction material shall be provided with clips.

2.10 CONTROL TOWER GLASS

****

NOTE: Requirements for control tower cab windows will be included in the project specification for Air Force construction. The use of these requirements by other agencies should be governed by agency criteria. Requirements for control tower cab windows are for the sizes and details on the current standard Air Force control tower drawings. Any modification from Air Force installations will be made only with the approval of Headquarters, U.S. Air Force. Edit this paragraph to include only the heat-absorbing insulating glass or the clear insulating glass.

Wind load requirements must be determined by the designer and the blanks filled in for each project.

If spare units are required for a particular project an "Extra Materials" paragraph must be developed for PART 1 which identifies the items, states quantities, and indicates to whom, when and where to be delivered.

For overseas work the following subparagraph will also be added:

1. When units other than United States manufacturer are proposed for use, the manufacturer shall prove successful use of the insulating window units in aircraft control tower cabs.

****

Control tower glass units shall be of sizes required to properly fit aluminum frames. Tolerances and clearances for units shall be designed to prevent the transfer of stress in aluminum frames to the glass. Resilient setting blocks, spacer strips, clips, bolts, washers, angles, glazing sealants, and resilient channels or cemented-on-materials shall be of the type recommended in the glass manufacturer's approved written instructions. Edges and corners of units shall not be ground, nipped, cut, or fitted after leaving the factory.

2.10.1 Control Tower Insulating Glass

Insulating glass units for air traffic control towers shall meet the wind load design requirement of [_____] psi, as determined in accordance with ASCE 7. Insulating glass shall be Class A preassembled units of dual-seal construction consisting of two lites of glass separated by a dark bronze aluminum, steel, or stainless steel, spacer with desiccant and dehydrated space conforming to ASTM E 773 and ASTM E 774. Spacer shall be roll-formed, with bent or tightly welded or keyed and sealed joints, to completely seal the spacer periphery to eliminate moisture and hydrocarbon vapor transmission into airspace through corners. Primary seal shall be compressed polyisobutylene. Secondary seal shall be silicone. Insulating glass units shall be fabricated for use at an elevation of [_____] feet above mean sea level and [_____] feet above grade. Within bottom 1/3 of one of the vertical edges of each unit, the manufacturer shall install an open 12 inch long capillary/breather tube for pressure equalization. The insulating glass units shall be free of parallax or optical distortions. The manufacturer's identifying label shall be permanently affixed to both exterior surfaces of the glass units. The insulating glass units shall be a total thickness of 1 inch consisting of two 1/4 inch thick panels and air space, or a total thickness of 1-1/4 inch consisting of two 3/8 inch thick panels and air space, or a total thickness of 1-1/2 inch consisting of two 1/2 inch thick panels and an air space, as required to meet the wind loads indicated. Glass type shall be as follows.

2.10.1.1 Control Tower Heat-Absorbing Insulating Glass

****
NOTE: Coordinate with paragraph Heat Absorbing Glass.
****

Heat-absorbing insulating glass shall consist of two glass panels separated by an air space and shall conform to ASTM C 1036, Type I, transparent flat glass, Style A, Quality q3 - glazing select. Interior glass shall be Class 1-clear and exterior glass shall be Class 2-tinted green. Glass performance shall be minimum Visible Transmittance of [70.8] [_____] percent for each panel and R-Value of 1.85 for the unit.

2.10.1.2 Control Tower Clear Insulating Glass

Clear insulating glass shall consist of two float glass panels separated by an air space and shall conform to ASTM C 1036, Type I transparent flat glass, Quality q3-glazing select. Interior glass and exterior glass shall be Class 1-clear. Glass performance shall be minimum Visible Transmittance of [87.3] [_____] percent for each panel and R-Value of 1.85 for each unit.

2.11 GLAZING ACCESSORIES

2.11.1 Preformed Tape

Preformed tape shall be elastomeric rubber extruded into a ribbon of a width and thickness suitable for specific application. Tape shall be of type which will remain resilient, have excellent adhesion, and be chemically compatible to glass, metal, or wood.

2.11.2 Sealant

Sealant shall be elastomeric conforming to ASTM C 920, Type S or M, Grade NS, Class 12.5, Use G, of type chemically compatible with setting blocks, preformed sealing tape and sealants used in manufacturing insulating glass. Color of sealant shall be [[as selected] [_____]] [as shown in Section

09915 COLOR SCHEDULE].

2.11.3 Glazing Gaskets

Glazing gaskets shall be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening shall be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets shall be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Glazing gasket profiles shall be as indicated on drawings.

2.11.3.1 Fixed Glazing Gaskets

Fixed glazing gaskets shall be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C 509, Type 2, Option 1.

2.11.3.2 Wedge Glazing Gaskets

Wedge glazing gaskets shall be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C 864, Option 1, Shore A durometer between 65 and 75.

2.11.3.3 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing shall be permanent, elastic, non-shrinking, non-migrating, watertight and weathertight.

2.11.4 Putty and Glazing Compound

Glazing compound shall conform to ASTM C 669 for face-glazing metal sash. Putty shall be linseed oil type conforming to CID A-A-378for face-glazing primed wood sash. Putty and glazing compounds shall not be used with insulating glass or laminated glass.

2.11.5 Setting and Edge Blocking

Neoprene setting blocks shall be dense extruded type conforming to ASTM D 395, Method B, Shore A durometer between 70 and 90. Edge blocking shall be Shore A durometer of 50 (+ or - 5). Silicone setting blocks shall be required when blocks are in contact with silicone sealant. Profiles, lengths and locations shall be as required and recommended in writing by glass manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

Openings and framing systems scheduled to receive glass shall be examined for compliance with approved shop drawings, GANA Glazing Manual and glass manufacturer's recommendations including size, squareness, offsets at corners, presence and function of weep system, face and edge clearance requirements and effective sealing between joints of glass-framing members. Detrimental materials shall be removed from glazing rabbet and glass surfaces and wiped dry with solvent. Glazing surfaces shall be dry and free of frost.

3.2 INSTALLATION

Glass and glazing work shall be performed in accordance with approved shop drawings, GANA Glazing Manual, glass manufacturer's instructions and warranty requirements. Glass shall be installed with factory labels intact and removed only when instructed. Wired glass and fire/safety rated glass shall be installed in accordance with NFPA 80. Edges and corners shall not be ground, nipped or cut after leaving factory. Springing, forcing or twisting of units during installation will not be permitted.

3.3 CLEANING

Upon completion of project, outside surfaces of glass shall be washed clean and the inside surfaces of glass shall be washed and polished in accordance with glass manufacturer's recommendations.

3.4 PROTECTION

Glass work shall be protected immediately after installation. Glazed openings shall be identified with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Reflective glass shall be protected with a protective material to eliminate any contamination of the reflective coating. Protective material shall be placed far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities shall be removed and replaced with new units.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-09250 (June 1997)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**
Superseding
CEGS-09250 (January 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 6 (September 1999)
Includes Special Change (Tailoring Options) (June 1998)

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****

SECTION 09250

GYPSUM WALLBOARD
06/97

****

NOTE: This guide specification covers the requirements for gypsum board, including regular, foil backed, fire-resistant, water-resistant and cementitious backer units. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for Fire-rated construction, pressurized enclosures, non-loadbearing walls, and loadbearing walls. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****

NOTE: Locations and details of trim and molding items for gypsum board will be indicated on the

drawings.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.11	(1992) Interior Installation of Cementitiuos Backup Units
ANSI A118.9	(1992) Test Methods and Spedifications for Cementitious Backer Units

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 580/A 580M	(1998) Stainless Steel Wire
ASTM A 853	(1993) Steel Wire, Carbon, for General Use
ASTM B 164	(1998) Nickel-Copper Alloy Rod, Bar, and Wire
ASTM C 36	(1997) Gypsum Wallboard
ASTM C 79/C 79M	(1997) Treated Core and Nontreated Core Gypsum Sheathing Board
ASTM C 475	(1994) Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C 514	(1996) Nails for the Application of Gypsum Board
ASTM C 557	(1993a) Adhesive for Fastening Gypsum Wallboard to Wood Framing
ASTM C 630/C 630M	(1996a) Water-Resistant Gypsum Backing Board
ASTM C 645	(1998) Nonstructural Steel Framing Members
ASTM C 754	(1997) Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM C 840	(1998) Application and Finishing of Gypsum Board

ASTM C 931/C 931M	(1995a) Exterior Gypsum Soffit Board
ASTM C 955	(1998) Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases
ASTM C 960/C 960M	(1997) Predecorated Gypsum Board
ASTM C 1002	(1998) Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases
ASTM C 1047	(1998) Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM C 1177/C 1177M	(1996) Glass Mat Gypsum Substrate for Use as Sheathing
ASTM C 1178/C 1178M	(1996) Glass Mat Water-Resistant Gypsum Backing Panel

GYPSUM ASSOCIATION (GA)

GA 216	(1996) Application and Finishing of Gypsum Board
GA 600	(1997) Fire Resistance Design Manual

UNDERWRITERS LABORATORIES (UL)

UL Fire Resist Dir	(1998) Fire Resistance Directory (2 Vol.)

1.2 SYSTEM DESCRIPTION

1.2.1 Fire-Rated Construction

****

NOTE: Review building code requirements for fire-rated construction, pressurized enclosures, stair and elevator shaft walls. Omit portions that do not apply.

****

Joints of fire-rated gypsum board enclosures shall be closed and sealed in accordance with UL test requirements or GA requirements, and as required to meet pressurization requirements. Penetrations through rated partitions and ceilings shall be sealed tight in accordance with tested systems. Fire ratings shall be as indicated.

1.2.2 Pressurized Enclosures

Pressurized fire-rated gypsum board enclosures shall allow the mechanical and electrical life-safety systems to operate in accordance with the design intent. Air pressure within elevator shaft shall be 7.5 psf. Air pressure within stair shaft shall be 5.0 psf. Maximum mid-span deflection shall be L/360.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Steel Framing; [_____]. Control Joints; [_____]. Fire-Resistant Assemblies ; [_____].

Drawings and installation details for ceiling framing, furring, special wall framing, and framed openings in walls and ceilings.

SD-13 Certificates

Gypsum Wallboard; [_____]. Water-Resistant Gypsum Board; [_____]. Exterior Gypsum Soffit Board; [_____]. Steel Framing; [_____]. Fire-Rated Gypsum Board; [_____]; Cementitious Backer Units; [_____].

Certificates stating that the steel framing and gypsum wallboard meet the specified requirements.

SD-14 Samples

Predecorated Gypsum Board; [_____].

Samples for each color and pattern of predecorated gypsum board. Where colors are not indicated, color selection samples of not less than [four] [_____] of manufacturer's standard colors shall be submitted.

1.4 QUALIFICATIONS

Manufacturer shall specialize in manufacturing the types of material specified and shall have a minimum of [5] [_____] years of documented successful experience. Installer shall specialize in the type of gypsum board work required and shall have a minimum of [3] [_____] years of documented successful experience.

1.5 DELIVERY, STORAGE AND HANDLING

Materials shall be delivered in original containers bearing the name of manufacturer, contents, and brand name. Materials shall be stored off the ground in a weathertight structure for protection. Gypsum boards shall be stacked flat, off floor and supported to prevent sagging and warpage. Adhesives and joint materials shall be stored in accordance with manufacturer's printed instructions. Damaged or deteriorated materials shall be removed from jobsite.

1.6 ENVIRONMENTAL CONDITIONS

Environmental conditions for application and finishing of gypsum board shall be in accordance with ASTM C 840. During the application of gypsum board without adhesive, a room temperature of not less than 40 degrees F shall be maintained. During the application of gypsum board with adhesive, a room temperature of not less than 50 degrees F shall be maintained for 48 hours prior to application and continuously afterwards until completely dry. Building spaces shall be ventilated to remove water not required for drying joint treatment materials. Drafts shall be avoided during dry hot weather to prevent materials from drying too rapidly.

PART 2 MATERIALS

2.1 NON-LOADBEARING STUD WALLS

2.1.1 Studs

Studs for non-loadbearing walls shall conform to ASTM C 645. Studs shall be C-shaped, roll formed steel with minimum uncoated design thickness of [0.0179 in] [0.0284 in] [0.0329 in] [_____] made from G40 hot-dip galvanized coated sheet.

2.1.2 Runner Tracks

Floor and ceiling runner tracks shall conform to ASTM C 645. Tracks shall be prefabricated, U-shaped with minimum 1 inch flanges, unpunched web, thickness to match studs, made from G40 hot-dip galvanized coated sheet.

2.2 LOADBEARING STUD WALLS

2.2.1 Studs

****

NOTE: Coordinate to assure that stud sizes and thickness are noted on the drawings. Minimum base metal design thickness will be 0.84 mm (0.0329 in), 1.12 mm (0.0438 in), 1.40 mm (0.0548 in), 1.78 mm (0.0697 in), or 2.45 mm (0.0965 in).

****

Studs for loadbearing walls shall conform to ASTM C 955. Studs shall be C-shaped roll formed steel made from minimum G60 hot-dip galvanized coated sheet. Stud sizes and base metal design thickness shall be as shown.

2.2.2 Runner Tracks

Floor and ceiling runner tracks shall conform to ASTM C 955. Runners shall be prefabricated, U-shaped with minimum 3/4 inch flanges, unpunched web, thickness to match studs, made from G60 hot-dip galvanized coated sheet.

2.2.3 Bridging

Bridging for loadbearing walls shall conform to ASTM C 955. Bridging shall be minimum 3/4 x 3/4 inch cold-rolled steel channel with weld attachment clips at each stud or V-bar type weld or screw attached to each stud flange. Bridging shall be adequate to provide lateral support for the stud.

2.3 SUSPENDED CEILING FRAMING

****

NOTE: Consult manufacturer's data for calculating design performance.

****

Suspended ceiling framing system shall have the capability to support the finished ceiling, light fixtures, air diffusers, and accessories, as shown. The suspension system shall have a maximum deflection of L/240. Carrying channels shall be formed from minimum 0.0548 in thick cold-rolled steel, 1-1/2 x 3/4 inch. Furring members shall be formed from cold-rolled steel, 7/8 x 2-9/16 inch. Carrying channels and furring members shall be made from hot-dip galvanized coated sheet.

2.4 GYPSUM BOARD

Gypsum board shall have square-cut ends, tapered or beveled edges and shall be maximum possible length. Gypsum board thickness shall be as shown.

2.4.1 Standard Gypsum Board

****

NOTE: Regular gypsum board can also be used as a tile base except do not use in wet areas such as tubs, shower enclosures, saunas, steam rooms or gang shower rooms. For gypsum board installations subject to moisture damage in the early stages of construction, water-resistant gypsum board of type specified in this section shall be used.

****

Regular gypsum board shall conform to ASTM C 36, and shall be 48 inches wide.

2.4.2 Fire-Rated Gypsum Board

Fire-rated gypsum board shall conform to ASTM C 36, and shall be Type X or Type C as required, 48 inches wide.

2.4.3 Water-Resistant Gypsum Board

****

NOTE: For wet areas such as tub and shower enclosures, use cementitious backer board (ANSI 118.9), or glass mat water-resistant gypsum backing panel, or mortar bed method as a base for adhesive-application of ceramic or plastic wall tile. Do not use water-resistant gypsum board (ASTM C 630/C 630M) in extremely critical wet areas such as saunas, steam rooms, gang shower rooms, or

directly over a vapor barrier. Use cementitious backer board or glass mat water-resistant gypsum backing panel in lieu of water-resistant gypsum board for adhesive application of ceramic or plastic tile on ceilings. For tile work, coordinate gypsum board requirements with tile manufacturer, ASTM C 840, ANSI A 136.1, and GA 216. Exposed-to-view water-resistant gypsum board is to be painted. Not all manufacturers provide a paintable water-resistant gypsum board.

****

Water-resistant gypsum board shall conform to ASTM C 630/C 630M, [regular] [Type X], with water-resistant paper faces, paintable surfaces, and shall be 48 inch width and maximum permissible length.

2.4.4   Foil-Backed Gypsum Board

****

NOTE: Foiled-backed gypsum board is not recommended for direct adhesive application and must not be used in the following areas: As a backing material for tile; for second ply on a two-ply laminating system; for laminating directly to masonry; in conjunction with electric heating cables. Foil-backed gypsum boards may be used where a vapor retarder is required.

****

Foil-backed gypsum board shall conform to ASTM C 36, [regular] [Type X], 48 inches wide. Gypsum board shall have aluminum foil vapor retarder laminated to back surface.

2.4.5   Predecorated Gypsum Board

Predecorated gypsum board shall conform to ASTM C 960/C 960M, 48 inches wide, [Class 1 with wallcovering applied in factory] [Class II with decorative pattern applied in factory]. Color shall be [_____] [in accordance with Section 09915 COLOR SCHEDULE].

2.4.6   Shaftwall Liner Panel

****

NOTE: Coreboards are designed to be used as a base in multilayer systems or as a gypsum stud or core in a semi-solid or solid gypsum board partition. Coreboards are 20 to 25 mm (3/4 to 1) thick typically used for elevator and stairwell shaftwalls.

****

Shaftwall liner panel shall conform to UL listing. Liner Panel shall be specifically manufactured for cavity shaftwall system, with water-resistant paper faces, bevel edges, single lengths to fit required conditions, [1] [3/4] [_____] inch thick, by 24 inches wide.

2.4.7   Exterior Gypsum Soffit Board

****

NOTE: Exterior gypsum soffit board is designed to be used for exterior soffits and carport ceilings that are completely protected from contact with liquid water.

****

Exterior gypsum soffit board shall conform to ASTM C 931/C 931M, [regular] [Type X], 48 inches wide.

2.4.8 Exterior Sheathing Board

****

NOTE: Exterior sheathing board is typically used in cavity wall construction such as metal studs and brick veneer. Glass mat gypsum sheathing is typically used with BIFS, brick, and all other exterior finishes and can be used in DEFS exterior soffit system.

****

Exterior sheathing board shall conform to ASTM C 79/C 79M, Type X, shall have water-resistant core, water-repellant paper faces each side, with tongue-and-groove edges, and be [24] inches wide, or square edges and 48 inches wide.

Glass mat gypsum sheathing shall conform to ASTM C 1177/C 1177M, shall have a water-resistant core with water and mold/mildew resistant fiberglass faces embedded into the core and shall have square edges 48 inches wide by [1/2 inch] [5/8 inch] thick.

2.4.9 Water-Resistant Gypsum Backing Panel

Glass mat water-resistant gypsum backing panels shall conform to ASTM C 1178/C 1178M, shall have a water-resistant cove with water and mold/mildew resistant fiberglass faces imbedded into the cove and shal have square edges 48 inches wide by [1/2 inch] [5/8 inch] thick.

2.5 TRIM, MOLDINGS, AND ACCESSORIES

2.5.1 Taping and Embedding Compound

Taping and embedding compound shall conform to ASTM C 475. Compound shall be specifically formulated and manufactured for use in embedding tape at gypsum wallboard joints and fastener heads, and shall be compatible with tape and substrate.

2.5.2 Finishing or Topping Compound

Finishing or topping compound shall conform to ASTM C 475. Compound shall be specifically formulated and manufactured for use as a finishing compound for gypsum board.

2.5.3 All-Purpose Compound

All-purpose compound shall be specifically formulated and manufactured to use as a taping and finishing compound, and shall be compatible with tape and substrate.

2.5.4 Joint Tape

Joint tape shall conform to ASTM C 475 and shall be as recommended by gypsum board manufacturer.

2.5.5 Trim, Control Joints, Beads, Stops and Nosings

Items used to protect edges, corners, and to provide architectural features shall be in accordance with ASTM C 1047.

2.6 FASTENINGS AND ADHESIVES

2.6.1 Nails

Nails shall conform to ASTM C 514. Nails shall be hard-drawn low or medium-low carbon steel, suitable for intended use. Special nails for predecorated gypsum board shall be as recommended by predecorated gypsum board manufacturer.

2.6.2 Screws

Screws shall conform to ASTM C 1002. Screws shall be self-drilling and self-tapping steel, [Type G for gypsum board to gypsum board] [Type S for wood or light-gauge steel framing] [Type W for wood framing].

2.6.3 Adhesives

Adhesives shall conform to ASTM C 557. Adhesives shall be formulated to bond gypsum board to wood framing members. For securing gypsum board to metal framing, adhesive shall be as recommended by gypsum board manufacturer.

2.6.4 Hangers

Suspended ceiling runner channel hangers shall be [soft, annealed steel wire not less than No. 8 SWG, conforming to ASTM A 853] [or] [flat iron or steel straps, at least 3/32 x 7/8 inch size, coated with zinc, cadmium, or rust-inhibiting paint].

2.6.5 Wire and Clip Type Fastenings

Tie wire, clips, rings, and other fastenings shall be [corrosion-resisting steel conforming to ASTM A 580/A 580M, composition 302, 304, or 316, Condition A,] [or] [nickel-copper alloy conforming to ASTM B 164, annealed condition] except that walls, partitions, and other vertical surfaces not incorporated in ceiling construction may be erected with soft, annealed steel conforming to ASTM A 853.

2.6.5.1 Tie Wire

Tie wire for constructing partitions and vertical furring, for securing metal lath to supports, and for lacing shall be not less than No. 18 SWG. Tie wire for other applications shall be not less than No. 16 SWG.

2.6.5.2 Clips

Clips used in lieu of tie wire for securing the furring channels to the runner channels in ceiling construction shall be made from strip not less than 1/8 inch thick or shall be hairpin clip, formed of wire not less than 0.01620 inch nominal diameter. Other clips and rings or fastenings of similar materials shall be equivalent in holding power to that provided by tie wire for the specific application.

2.7 CEMENTITIOUS BACKER UNITS

Cementitious backer units shall comply with ANSI A118.9.

PART 3 EXECUTION

3.1 INTERIOR WALL FRAMING

Steel framing and furring members shall be installed in accordance with ASTM C 754. Members shall be in alignment with spacings not to exceed the maximum spacings indicated on drawings. Runners shall be aligned accurately at the floor and ceiling and securely anchored.

3.1.1 Wall Openings

****

NOTE: For added frame resistance, spot-grouting at the jamb anchor clip is recommended. Jamb framing should be for door size and weight. Full grouting for heavy and large frames is suggested.

****

The framing system shall provide for the installation and anchorage of the required subframes or finish frames for wall openings at doors, pass-through openings, and access panels. Partitions abutting continuous suspended ceilings shall be strengthened for rigidity at rough openings of more than 30 inches wide. Studs at openings shall be 0.0329 in minimum bare metal thickness and spot grouted at jamb anchor inserts. Double studs shall be fastened together with screws and secured to floor and overhead runners. Two studs shall be used for framing solid-core doors, doors over 36 inches wide and extra-heavy doors such as X-ray room doors.

3.1.2 Wall Control Joints

Control joints for expansion and contraction in the walls shall be constructed with double studs installed 1/2 inch apart in interior walls or wall furrings where indicated on drawings. Control joint spacing shall not exceed 30 feet. Ceiling-height door frames may be used as vertical control joints. Door frames of less than ceiling height may be used as control joints only if standard control joints extend to ceiling from both corners of top of door frame. Control joints between studs shall be filled with firesafing insulation in fire rated partitions.

3.1.3 Blocking

Blocking shall be provided as necessary for mounted equipment. Blocking shall be metal or wood and shall be cut to fit between framing members. Blocking shall be regidly anchored to the framing members. Under no circumstances will accessories or other wall mounted equipment be anchored directly to gypsum wallboard.

3.2 SHAFT WALL FRAMING

The shaft wall system shall be installed in accordance with the system manufacturer's published instructions. Bucks, anchors, blocking and other items placed in or behind shaft wall framing shall be coordinated with electrical and mechanical work. Fireproofing materials which are damaged or removed during shaft wall construction shall be patched or replaced.

3.3 SUSPENDED CEILING FRAMING

Suspended ceiling system framing shall be installed in accordance with ASTM C 754.

3.3.1 Hangers

Hangers shall be spaced not more than 48 inches along runner channels and 36 inches in the other direction or 42 inches in both directions unless otherwise indicated. Locations of hanger wires shall be coordinated with other work. Hangers at ends of runner channels shall be located not more than 6 inches from wall. Hanger wire shall be looped around bottom chord of open-web steel joists, or secured to structural elements with suitable fasteners. Sags or twists which develop in the suspended system shall be adjusted. Damaged or faulty parts shall be replaced.

3.3.2 Main Runners

Main runner channels shall be installed in accordance with ASTM C 754. Hanger wires shall be double strand saddle-tied to runner channels and the ends of hanger wire shall be twisted three times around itself. Main runners shall be located to within 6 inches of the paralleling wall to support the ends of cross furring. Main runners shall not come in contact with abutting masonry or concrete walls. Where main runners are spliced, ends shall be overlapped 12 inches with flanges of channels interlocked, and shall be securely tied at each end of splice with wire looped twice around the channels.

3.3.3 Furring Channels

Furring channels shall be spaced in accordance with ASTM C 754. Furring channels shall be secured to the runner channels and to structural supports at each crossing with tie wire, hairpin clips, or equivalent fastenings. Furring channels shall be located within 2 inches of parallel walls and beams, and shall be cut 1/2 inch short of abutting walls.

3.3.4 Ceiling Openings

Support members shall be provided as required at ceiling openings for access panels, recessed light fixtures, and air supply or exhaust. Support members shall be not less than 1-1/2 inch main runner channels and vertically installed suspension wires or straps shall be located to provide at least the minimum support specified herein for furring and wallboard attachment. Intermediate structural members not a part of the structural system, shall be provided for attachment or suspension of support members.

3.3.5 Light Fixtures and Air Diffusers

Light fixtures and air diffusers shall be supported directly from suspended ceiling runners. Wires shall be provided at appropriate locations to carry the weight of recessed or surface mounted light fixtures and air diffusers.

3.3.6 Control Joints

Ceiling control joints for expansion and contraction shall be located where indicated on drawings. A control joint or intermediate blocking shall be installed where ceiling framing members change direction.

3.3.6.1 Interior Ceilings With Perimeter Relief

Control joints shall be installed so that linear dimensions between control joints shall not exceed 50 feet in either direction nor more than 2500 square feet.

3.3.6.2 Interior Ceilings Without Perimeter Relief

Control joints shall be installed so that linear dimensions between control joints shall not exceed 30 feet in either direction nor more than 900 square feet.

3.3.6.3 Exterior Ceilings

Control joints shall be installed so the linear dimensions between control joints shall not exceed 30 feet in either direction nor more than 900 square feet.

3.4 APPLICATION OF GYPSUM BOARD

Gypsum board shall be installed in accordance with ASTM C 840 and GA 216 and as specified. Paragraph 17.3.1 GENERAL of ASTM C 840 which permits usage of water resistant gypsum board as a base for adhesive application of ceramic or plastic tile on ceilings, does not apply. Edges and ends of gypsum boards shall be cut to obtain neat fitting joints. End joints of adjoining boards shall be staggered, and shall be staggered on opposite sides of wall. Boards shall be applied with moderate contact without forcing in place. Holes for pipes, fixtures or other small openings shall be cut with a tool which will provide a neat fit. Screws shall be driven so that the heads are slightly below the plane of paper face. Fracturing the paper face or damaging the core shall be avoided. Trim shall be installed at external and internal angles formed by the intersecting gypsum board surfaces with other surfaces. Corner beads shall be installed to vertical and horizontal corners in accordance with manufacturer's published instructions.

3.4.1 Two-Ply Gypsum Board

Second layer of gypsum board shall be applied perpendicular to first layer with joints staggered and secured with [mechanical fasteners] [adhesive]. The use of adhesive shall be in accordance with ASTM C 840.

3.4.2 Foil-Backed Gypsum Board

Foil-backed gypsum board shall be placed with reflective surface against framing members.

3.4.3 Water-Resistant Gypsum Board

Water-resistant gypsum board shall be installed at the locations indicated.

3.4.4 Adhesively-Applied Gypsum Board

Walls scheduled to receive adhesively-applied gypsum board shall be dry, free of dust, oil, or form release agents, protrusions or voids, or foreign matter that would affect a proper bond.

3.4.5 Exterior Gypsum Sheathing

Exterior gypsum sheathing and glass mat gypsum sheathing shall be flashed at openings so that water intrusion will not contact the sheathing. Vertical end and edge joints shall abut over the centers of framing members and shall be offset a minimum of one framing space between adjacent rows of gypsum sheathing. Sheathing shall be installed in accordance with manufacturer's instructions.

3.5 TRIM, MOLDINGS, AND ACCESSORIES INSTALLATION

Trim, moldings and accessories shall be installed in accordance with GA 216.

3.6 TAPING AND FINISHING

Gypsum board taping and finishing shall be performed in accordance with ASTM C 840. Boards shall be kept free of dirt, oil and other foreign matter that could cause a lack of bond. Screw heads, dents, gouges, and cut-outs shall be filled with joint compound and sanded. Accessories at exposed joints, edges, corners, openings, and similar locations shall be taped, floated with joint compound, and sanded to produce surfaces ready for gypsum board finishes.

3.7 APPLICATION OF CEMENTITIOUS BACKER UNITS

Cementitious backer units shall be installed in accordance with ANSI A108.11. Fasteners shall be the type designed for cement board application.

3.8 FIRE-RESISTANT ASSEMBLIES

****

NOTE: Where a specific degree of fire resistance is required for gypsum wallboard assemblies and constructions, applicable systems from UL Fire Resistance Directory or FM Products Guide will be used and the UL or FM design numbers will be indicated on the drawings. Construction details for fire resistance and sound control are also described in the Gypsum Association's Fire Resistance Design Manual, and are based on official reports of fire and sound tests conducted by recognized testing laboratories in accordance with applicable standards of ASTM including E 90, E 119, E 336, and E 492. Designers should closely adhere to tested designs, since seemingly small changes such as change in material type or thickness, can affect the fire resistance and sound transmission of a structure. Designers shall exercise care in specifying a UL assembly, since specifying the assembly could result in a proprietary specification.

****

Gypsum wallboard construction for fire-rated assemblies shall be in accordance with UL Fire Resist Dir, or GA 600 for the design number indicated on drawings.

3.9 PATCHING

Surface defects and damage shall be corrected as required to leave gypsum board smooth, uniform in appearance, and ready to receive finish as specified.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-09310 (July 1998)**
U.S. ARMY CORPS OF ENGINEERS **----------------------**
Superseding
CEGS-09310 (October 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 2 (July 1999)
Includes Text Adjustment (Section References) (November 1998)
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SECTION 09310

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07/98

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SECTION 09310

CERAMIC TILE
07/98

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NOTE: This guide specification covers the requirements for ceramic tile for walls and floors, quarry tile, and marble thresholds. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for mosaic tile, quarry tile, detectable warning tile, glazed wall tile, and marble thresholds. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****
NOTE: Buildings not excluded by AEI Design Criteria will be accessible in accordance with 36 CFR, Part 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities.

Drawings will indicate location, dimensions, elevations, schedules, content, details and such other information as required to indicate the extent of the work.

Product selections shall be based on esthetic values, function, type of facility, and cost as related to project needs.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.1A	(1992) Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar
ANSI A108.1B	(1992) Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex Portland Cement Mortar
ANSI A108.4	(1992) Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile Setting Epoxy Adhesive
ANSI A108.5	(1992) Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar
ANSI A108.6	(1992) Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and Grouting Epoxy
ANSI A108.7	(1992) Electrically Conductive Ceramic Tile Installed with Conductive Dry-Set Portland Cement Mortar
ANSI A108.8	(1992) Installation of Ceramic Tile with Chemical Resistant Furan Mortar and Grout

ANSI A108.10	(1992) Installation of Grout in Tilework
ANSI A118.1	(1992) Dry-Set Portland Cement Mortar
ANSI A118.2	(1992) Conductive Dry-Set Portland Cement Mortar
ANSI A118.3	(1992) Chemical Resistant, Water Cleanable Tile Setting and Grouting Epoxy and Water Cleanable Tile Setting Epoxy Adhesive
ANSI A118.4	(1992) Latex-Portland Cement Mortar
ANSI A118.5	(1992) Chemical Resistant Furan Mortars and Grouts for Tile
ANSI A118.6	(1992) Ceramic Tile Grouts
ANSI A136.1	(1992) Organic Adhesives for Installation of Ceramic Tile
ANSI A137.1	(1988) Ceramic Tile

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185	(1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM C 33	(1997) Concrete Aggregates
ASTM C 144	(1997) Aggregate for Masonry Mortar
ASTM C 150	(1997) Portland Cement
ASTM C 206	(1984; R 1997) Finishing Hydrated Lime
ASTM C 207	(1991; R 1997) Hydrated Lime for Masonry Purposes
ASTM C 241	(1990) Abrasion Resistance of Stone Subjected to Foot Traffic
ASTM C 373	(1988; R 1994) Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products
ASTM C 648	(1984; R 1994) Breaking Strength of Ceramic Tile
ASTM C 847	(1995) Metal Lath
ASTM C 1026	(1987; R 1996) Measuring the Resistance of Ceramic Tile to Freeze-Thaw Cycling
ASTM C 1027	(1984; R 1990) Determining Visible Abrasion Resistance of Glazed Ceramic Tile

ASTM C 1028	(1996) Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method

MARBLE INSTITUTE OF AMERICA (MIA)

MIA Design Manual	(1991) Design Manual IV Dimensional Stone

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 99	(1999) Health Care Facilities

TILE COUNCIL OF AMERICA (TCA)

TCA Hdbk	(1997) Handbook for Ceramic Tile Installation

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Tile; [_____]. Setting-Bed; [_____]. Mortar, Grout, and Adhesive; [_____].

Manufacturer's catalog data.

SD-06 Instructions

Tile; [_____]. Mortar and Grout; [_____].

Manufacturers preprinted installation and cleaning instructions.

SD-09 Reports

Testing; [_____].

Copy of results for electrical resistance tests.

SD-13 Certificates

Tile; [_____]. Mortar, Grout, and Adhesive; [_____].

Certificates indicating conformance with specified requirements. A master grade certificate shall be furnished for tile.

SD-14 Samples

Tile; [_____]. Accessories; [_____]. Marble Thresholds; [_____].

Samples of sufficient size to show color range, pattern, type and joints.

1.3 DELIVERY AND STORAGE

Materials shall be delivered to the project site in manufacturer's original unopened containers with seals unbroken and labels and hallmarks intact. Materials shall be kept dry, protected from weather, and stored under cover in accordance with manufacturer's instructions.

1.4 ENVIRONMENTAL REQUIREMENTS

Ceramic tile work shall not be performed unless the substrate and ambient temperature is at least 50 degrees F and rising. Temperature shall be maintained above 50 degrees F while the work is being performed and for at least 7 days after completion of the work. When temporary heaters are used they shall be vented to the outside to avoid carbon dioxide damage to new tilework.

1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1-year period shall be provided.

PART 2 PRODUCTS

****

NOTE: Color and pattern must be indicated. When manufacturer's names, colors, and patterns are shown, add the following sentence: Colors listed are for color identification purpose only; the listing is not intended to limit selection of similar colors from other manufacturers.

The surface datum will be established for the top of the tile floors to indicate to other trades the required elevation for the top of subfloor.

****

2.1 TILE

****

NOTE: Unglazed ceramic tile with low absorption rates are easier to maintain because they are more resistant to staining. They do not readily absorb grease, food or beverage spills, or other staining agents.

A minimum coefficient of friction of 0.50 (wet and

dry) is the recognized industry standard for a slip-resistant flooring surface. The Americans with Disabilities Act (ADA) recommends a minimum coefficient of friction of 0.60 (wet and dry) for accessible routes and 0.80 (wet and dry) for ramps.

The basic durability classifications for floors are as follows:

Class 0 - Generally not recommended for use on floors.

Class I - Light Traffic, residential bathroom floors.

Class II - Medium-Light Traffic, residential interiors except kitchens, stairs, landings, and areas near exterior entries.

Class III - Medium-Heavy Traffic, all residential applications and similar commercial applications except areas of prevalent circulation or turning points.

Class IV - Heavy Traffic, all residential and most commercial applications such as public areas of exhibition halls, shops, and schools.

Class IV Plus - Extra Heavy Traffic; walkways, food service, etc., or where extra wear is required.
****

Tile shall be standard grade conforming to ANSI A137.1. Containers shall be grade sealed. Seals shall be marked to correspond with the marks on the signed master grade certificate. Tile shall be impact resistant with a minimum breaking strength for wall tile of 90 lbs and 250 lbs for floor tile in accordance with ASTM C 648. Tile for cold climate projects shall be rated frost resistant by the manufacturer as determined by ASTM C 1026. Water absorption shall be [0.50] [_____] maximum percent in accordance with ASTM C 373. Floor tile shall have a minimum coefficient of friction of [0.50] [0.60] [_____] wet and dry in accordance with ASTM C 1028. Floor tile shall be Class [III-Medium Heavy][IV-Heavy] [IV Plus-Extra Heavy] [_____] Traffic, durability classification as rated by the manufacturer when tested in accordance with ASTM C 1027for abrasion resistance as related to foot traffic.

2.1.1 Mosaic Tile

Ceramic mosaic tile and trim shall be unglazed [[natural clay] [conductive] with cushion edges] [porcelain [unpolished] [polished] with sharply formed face]. Tile size shall be [1 x 1 inch] [1 x 2 inches] [2 x 2 inches] [a mixture of standard sizes in a stock pattern] [_____]. Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

2.1.2 Quarry Tile

****

NOTE: Abrasive surface quarry tile will be specified for vestibules, kitchens, walk-in refrigerators, and work spaces behind serving lanes. Abrasive surface quarry tile should be considered for other areas which may become slippery due to grease or soapy water spillage or for other reasons. Red quarry tile is the most economical color. If other colors are desired, they should be limited to the darker shades.

****

Quarry tile and trim shall be unglazed with [smooth surface] [abrasive surface]. Tile shall be [6 x 6] [_____] x 1/2 inch. Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

2.1.3 Detectable Warning Tile

Detectable warning tile shall be unglazed with raised truncated domes with a diameter of nominal 0.9 inch at a height of nominal 0.2 inch and a center-to-center spacing of nominal 2.35 inches and shall contrast visually with adjoining surfaces. Tile shall be [6 x 6] [_____] x 1/2 inch. Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

2.1.4 Glazed Wall Tile

****

NOTE: One type of finish will be retained. Generally, matte glaze will be used; however, bright glaze may be selected where a glossy finish would not be objectionable.

****

Glazed wall tile and trim shall be cushion edged with [bright] [matte] glaze. Tile shall be [4-1/4 x 4-1/4] [4-1/4 x 6] [6 x 6] inches. Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

2.1.5 Accessories

****

NOTE: Where glazed accessories are required, the color, style, and number will be inserted and locations indicated on the drawings. This paragraph will be coordinated with Section 10800 TOILET ACCESSORIES.

****

Accessories shall be the built-in type of the same materials and finish as the wall tile. Accessories shall be provided as follows: [_____].

2.2 SETTING-BED

The setting-bed shall be composed of the following:

2.2.1 Aggregate for Concrete Fill

Aggregate shall conform to ASTM C 33. Maximum size of coarse aggregate shall not be greater than one-half the thickness of concrete fill.

2.2.2 Portland Cement

Cement shall conform to ASTM C 150, Type I, white for wall mortar and gray for other uses.

2.2.3 Sand

Sand shall conform to ASTM C 144.

2.2.4 Hydrated Lime

Hydrated lime shall conform to ASTM C 206, Type S or ASTM C 207, Type S.

2.2.5 Metal Lath

Metal lath shall be flat expanded type conforming to ASTM C 847, and weighing not less than 2.5 pounds per square yard.

2.2.6 Reinforcing Wire Fabric

Wire fabric shall conform to ASTM A 185. Wire shall be either 2 x 2 inch mesh, 16/16 wire or 1-1/2 x 2 inch mesh, 16/13 wire.

2.3 WATER

Water shall be potable.

2.4 MORTAR, GROUT, AND ADHESIVE

Mortar, grout, and adhesive shall conform to the following:

2.4.1 Dry-Set Portland Cement Mortar

ANSI A118.1.

2.4.2 Conductive Dry-Set Mortar

ANSI A118.2.

2.4.3 Latex-Portland Cement Mortar

ANSI A118.4.

2.4.4 Ceramic Tile Grout

ANSI A118.6; [sand portland cement grout] [dry-set grout] [latex-portland cement grout] [commercial portland cement grout] [silicone rubber grout].

2.4.5 Organic Adhesive

ANSI A136.1, Type I.

2.4.6 Epoxy Resin Grout

ANSI A118.3.

2.4.7 Furan Resin Grout

ANSI A118.5 and consist of an intimate mixture of furfuryl-alcohol resin with carbon filler and catalyst.

2.5 MARBLE THRESHOLDS

****
NOTE: Where the top of tile floors will occur at a different elevation from the top of finished floors in adjoining spaces, provision for marble thresholds or saddles will be edited appropriately.
****

Marble thresholds shall be of size required by drawings or conditions. Marble shall be Group A as classified by MIA Design Manual. Marble shall have a fine sand-rubbed finish and shall be [white] [pink] [or] [gray] in color as approved by the Contracting Officer. Marble abrasion shall be not less than 12.0 when tested in accordance with ASTM C 241.

PART 3 EXECUTION

3.1 PREPARATORY WORK AND WORKMANSHIP

****
NOTE: When using the dry-set method to install tile on concrete or masonry surfaces, Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE and Section 04200 MASONRY, as applicable, will be coordinated to require (1) steel trowel and fine broom-finished concrete floors free of curing compounds and waxes, (2) masonry surfaces that are level and plumb with struck joints and square openings.
****

Surface to receive tile shall be inspected and shall conform to the requirements of ANSI A108.1A or ANSI A108.1B for surface conditions for the type setting bed specified and for workmanship. Variations of surface to be tiled shall fall within maximum values shown below:

TYPE	WALLS	FLOORS
Dry-Set Mortar	1/8 inch in 8 ft.	1/8 inch in 10 ft.
Organic Adhesives	1/8 inch in 8 ft.	1/16 inch in 3 ft.
Latex portland cement mortar	1/8 inch in 8 ft.	1/8 inch in 10 ft.
Epoxy	1/8 inch in 8 ft.	1/8 inch in 10 ft.

3.2 GENERAL INSTALLATION REQUIREMENTS

Tile work shall not be started until roughing in for mechanical and electrical work has been completed and tested, and built-in items requiring membrane waterproofing have been installed and tested. Floor tile installation shall not be started in spaces requiring wall tile until after wall tile has been installed. Tile in colors and patterns indicated shall be applied in the area shown on the drawings. Tile shall be installed with the respective surfaces in true even planes to the elevations and grades shown. Special shapes shall be provided as required for sills, jambs, recesses, offsets, external corners, and other conditions to provide a complete and neatly finished installation. Tile bases and coves shall be solidly backed with mortar.

3.3 INSTALLATION OF WALL TILE

****

NOTE: This paragraph covers three different methods of installing tile on walls: the mortar bed method W211, W221, W222, W231, and W241; direct to masonry with dry-set mortar W202; and the organic adhesive method W223, and W242, 243 or 244. See TCA Hdbk for detailed guidance.

General guidance is as follows:

The mortar bed method or cementitious backer board method will be used for all prolonged wet areas such as showers. Ceramic tile over gypsum board will be used only in dry areas.

Dry-set mortar applied direct to masonry is suitable for all but prolonged wet areas such as showers.

The organic adhesive method will be limited to dry areas and will generally be used over gypsum wallboard.

Where more than one method is used for the same project, care must be taken to ensure that the drawings clearly indicate the various substrates and where each method is used. Where only one method is used on a project, clearly specify that method only.

****

Wall tile shall be installed in accordance with the TCA Hdbk, method [_____].

3.3.1 Workable or Cured Mortar Bed

Tile shall be installed over a workable mortar bed or a cured mortar bed at the option of the Contractor. A 4 mil polyethylene membrane, metal lath, and scratch coat shall also be installed. Workable mortar bed, materials, and installation of tile shall conform to ANSI A108.1A. Cured mortar bed and materials shall conform to ANSI A108.1B.

3.3.2 Dry-Set Mortar and Latex-Portland Cement Mortar

[Dry-set] [or] [Latex-portland cement] shall be used to install tile in accordance with ANSI A108.5. Latex portland cement shall be used when installing porcelain ceramic tile.

3.3.3 Organic Adhesive

Organic adhesive installation of ceramic tile shall conform to ANSI A108.4.

3.3.4 Furan Mortar and Grout

Furan mortar and grout installation shall conform to ANSI A108.8.

3.4 INSTALLATION OF FLOOR TILE

****

NOTE: This paragraph covers two different methods of installing tile on floors. The mortar bed method F111, F112, F114, and F121 and direct to concrete with dry-set mortar method F113 and F115. See TCA Hdbk for detailed guidance.

General guidance is as follows:

The mortar bed method will be used for areas having a floor drain.

Dry-set mortar direct to concrete is suitable for areas without a floor drain or when it is not practical to recess the slab.

Where more than one method is used for the same project, care must be taken to ensure that the drawings clearly indicate the various substrates and where each method is used. Where only one method is used on a project, clearly specify that method only.

****

Floor tile shall be installed in accordance with TCA Hdbk, method [_____]. Shower receptors shall be installed in accordance with TCA Hdbk, method [B414] [B415].

3.4.1 Workable or Cured Mortar Bed

Floor tile shall be installed over a workable mortar bed or a cured mortar bed at the option of the Contractor. Workable mortar bed materials and installation shall conform to ANSI A108.1A. Cured mortar bed and materials shall conform to ANSI A108.1B. Joints between quarry tile shall be between 1/4 inch and 3/8 inch in width and shall be uniform in width.

3.4.2 Dry-Set and Latex-Portland Cement

[Dry-set] [or] [Latex-portland cement] mortar shall be used to install tile directly over properly cured, plane, clean concrete slabs in accordance with ANSI A108.5. Latex portland cement shall be used when installing porcelain ceramic tile.

3.4.3 Resinous Grout

****

NOTE: Resin grout will be used where chemical resistance is required. The areas to receive resin grout must be clearly indicated on the drawings or defined in the specifications. Due to the higher cost of this grout, its use will generally be limited to areas such as:

a. Within the areas bounded by a line 600 mm (2 feet) outside of the trough areas for ranges,

kettles, and ovens.

b. Within the areas of potwashing and dishwashing. In small kitchens where it may be impracticable to subdivide areas for grouting, resin grout method F114 or F133 may be used throughout.

For severe chemical exposure such as meat packing plants and photo labs, resin grout method F134 will be used throughout and a resin setting-bed will be required. Wherever resin setting-bed is used, the concrete slab will be steel-troweled finished to the final slope of the finished floor. The tile shall be set in a 3 mm (1/8 inch) thick layer of epoxy-or furan-resin mortar. When using furan resins, the concrete slab will be neutralized or painted in accordance with the resin manufacturer's directions.
****

When resinous grout is indicated, quarry tile shall be grouted with either furan or epoxy resin grout. Joints shall be raked and cleaned to the full depth of the tile and neutralized when recommended by the resin manufacturer. Epoxy resin grout shall be installed in conformance with ANSI A108.6. Furan resin grout shall be installed in accordance with manufacturer's instructions. Tile installed with furan resin shall be coated with wax by the tile manufacturer. Installation of resin grout shall be in strict accordance with manufacturer's instructions for proportioning, mixing, installing, and curing. Recommended temperature shall be maintained in the area and on the surface to be grouted. After grouting, tile shall be left free of grout stain.

3.4.4 Ceramic Tile Grout

Ceramic Tile grout shall be prepared and installed in accordance with ANSI A108.10.

3.4.5 Waterproofing

Shower pans are specified in Section 15400 PLUMBING, GENERAL PURPOSE. Waterproofing under concrete fill shall conform to the requirements of Section 07132 BITUMINOUS WATERPROOFING.

3.4.6 Concrete Fill

****
NOTE: In areas to receive conductive ceramic tile, the first sentence will be chosen.
****

[Concrete fill shall be 3500 psi concrete, mixed to as dry a consistency as practicable.] [Concrete fill shall be composed by volume of 1 part portland cement to 3 parts fine aggregate to 4 parts coarse aggregate, and mixed with water to as dry a consistency as practicable.] The fill shall be spread, tamped, and screeded to a true plane, and pitched to drains or leveled as shown. Concrete fill shall be thoroughly damp cured before application of setting-bed material . Concrete fill shall be reinforced with one layer of reinforcement, with the uncut edges lapped the width of one mesh and the cut ends and edges lapped not less than 2 inches. Laps shall be tied together with 18 gauge wire every 10 inches along the finished edges and every 6 inches along the cut ends and edges. The reinforcement shall be supported and secured in the centers of concrete fills. The mesh shall be continuous; except where expansion joints occur, mesh shall be cut and discontinued across such joints. Reinforced concrete fill shall be provided under the setting-bed where the distance between the under-floor surface and the finished tile floor surface is 2 inches or greater, and shall be of such thickness that the mortar setting-bed over the concrete fill shall be not less nor more than the thickness required in the specified TCA Hdbk methods.

3.5 INSTALLATION OF CONDUCTIVE FLOORING

Conductive ceramic mosaic tile floors shall be installed in accordance with ANSI A108.7.

3.6 INSTALLATION OF MARBLE THRESHOLDS

****

NOTE: Where the top of tile floors will occur at a different elevation from the top of finished floors in adjoining spaces, provision for marble thresholds or saddles will be edited appropriately.

****

Thresholds shall be installed where indicated in a manner similar to that of the ceramic tile floor. Thresholds shall be the full width of the opening. Head joints at ends shall not exceed 1/4 inch in width and shall be grouted full as specified for ceramic tile.

3.7 TESTING

Electrical resistance tests shall be performed on conductive flooring in the presence of the Contracting Officer by a technician experienced in such work and a copy of the test results shall be furnished. Test procedures, testing apparatus, and test results shall be in accordance with the provisions for Conductive Flooring in NFPA 99.

3.8 EXPANSION JOINTS

****

Note: Expansion-joint details will be indicated on the drawings. Details as provided in TM 5-805-6 will be used as applicable. Location of expansion joints should, insofar as practical, be located outside the areas of tile finishes.

****

Joints shall be formed as indicated and sealed as specified in Section 07900 JOINT SEALING.

3.8.1 Walls

Expansion joints shall be provided at control joints in backing material. Wherever backing material changes, an expansion joint shall be installed to separate the different materials.

3.8.2 Floors

****
NOTE: Second sentence will be deleted for projects where the use of tile is limited to small areas or long narrow corridors or where chemical resistant grouts are used.
****

Expansion joints shall be provided over construction joints, control joints, and expansion joints in concrete slabs. Expansion joints shall be provided where tile abuts restraining surfaces such as perimeter walls, curbs and columns and at intervals of 24 to 36 feet each way in large interior floor areas and 12 to 16 feet each way in large exterior areas or areas exposed to direct sunlight or moisture. Expansion joints shall extend through setting-beds and fill.

3.9 CLEANING AND PROTECTING

Upon completion, tile surfaces shall be thoroughly cleaned in accordance with manufacturer's approved cleaning instructions. Acid shall not be used for cleaning glazed tile. Floor tile with resinous grout or with factory mixed grout shall be cleaned in accordance with instructions of the grout manufacturer. After the grout has set, tile wall surfaces shall be given a protective coat of a noncorrosive soap or other approved method of protection. Tiled floor areas shall be covered with building paper before foot traffic is permitted over the finished tile floors. Board walkways shall be laid on tiled floors that are to be continuously used as passageways by workmen. Damaged or defective tiles shall be replaced.

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-09510 (August 1996)**
U.S. ARMY CORPS OF ENGINEERS | **------------------------**
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CEGS-09510 (April 1995)

GUIDE SPECIFICATION FOR CONSTRUCTION

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Includes Special Change (Tailoring Options) (April 1998)

Latest change indicated by CHG tags
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SECTION 09510

ACOUSTICAL CEILINGS
08/96

****

NOTE: This guide specification covers the requirements for acoustical ceiling tile, hangers, and suspension system grid for installation in commercial-type work. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL: http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for exposed grid system units, concealed grid system units, and metal pan units. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****

Note: Plaster or gypsum wallboard ceilings, metal

faced or ceramic-bonded mineral fiber acoustical ceilings should be used in lieu of mineral fiber or fiberglass base acoustical ceiling systems in wet areas such as showers and bathrooms or around grills, in kitchens, and similar facilities where greasy vapors are a problem.

Where acoustical ceilings are provided in conjunction with thermal insulation beneath vented attic spaces, careful attention should be given to furnishing the appropriate type ceiling tile, adequate details on the contract drawings, and to including appropriate sections in the specifications. Details on the drawings will cover such features as support of insulation at flush-mounted light fixtures, conduit, acoustical units, suspension system components, heating and air-conditioning units, and other utilities. Installation of insulation over the suspension systems, light fixtures, and other ceiling penetrations will be coordinated with Section 06100 ROUGH CARPENTRY and manufacturer's literature.
****

1.1   REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 635	(1995) Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C 636	(1996) Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM E 119	(1995a) Fire Tests of Building Construction and Materials
ASTM E 580	(1996) Application of Ceiling Suspension Systems for Acoustical Tile and Lay In Panels in Areas Requiring Seismic Restraint
ASTM E 1264	(1990) Standard Classification for Acoustical Ceiling Products

ASTM E 1414	(1991a) Standard Test for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum

COE TECHNICAL INSTRUCTIONS (TI)

TI 809-04	(1998) Seismic Design for Buildings

UNDERWRITERS LABORATORIES (UL)

UL Fire Resist Dir	(1997) Fire Resistance Directory (2 Vol)

1.2 GENERAL REQUIREMENTS

****

NOTE: Drawings should indicate the following:

a. Arrangement of acoustical units, light fixtures, and diffusers.

b. Location of systems required to have ceiling attenuation class (CAC).

c. Location and details of system required to have a fire resistive rating.

d. Location and details and material of fire stops above suspended systems.

e. Location and details of access panels.

f. Location of each different color and pattern when more than one type acoustical unit is specified for a project.

****

Acoustical treatment shall consist of sound controlling units mechanically mounted on a ceiling suspension system. The unit size, texture, finish, and color shall be as specified. . The location and extent of acoustical treatment shall be as shown on the drawings. Reclamation of mineral fiber acoustical ceiling panels to be removed from the job site shall be in accordance with paragraph RECLAMATION PROCEDURES.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Acoustical Ceiling System; [_____].

Manufacturer's descriptive data, catalog cuts, and installation instructions. Submittals which do not provide adequate data for the product evaluation will be rejected.

SD-04 Drawings

Acoustical Ceiling System; [_____].

Drawings showing suspension system, method of anchoring and fastening, details, and reflected ceiling plan.

SD-09 Reports

Fire Resistive Ceilings; [_____]. Ceiling Attenuation Class and Test; [_____].

Reports by an independent testing laboratory attesting that acoustical ceiling systems meet specified [fire endurance] [and] [sound transmission] requirements. Data attesting to conformance of the proposed system to Underwriters Laboratories requirements for the fire endurance rating listed in UL Fire Resist Dir may be submitted in lieu of test reports.

SD-13 Certificates

Acoustical Units; [_____].

Certificate attesting that the mineral based acoustical units furnished for the project contains recycled material and showing an estimated percent of such material.

SD-14 Samples

Acoustical Units; [_____].

Two samples of each type of acoustical unit and each type of suspension grid tee section showing texture, finish, and color.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in the manufacturer's original unopened containers with brand name and type clearly marked. Materials shall be carefully handled and stored in dry, watertight enclosures. Immediately before installation, acoustical units shall be stored for not less than 24 hours at the same temperature and relative humidity as the space where they will be installed in order to assure proper temperature and moisture acclimation.

1.5 ENVIRONMENTAL REQUIREMENTS

A uniform temperature of not less than 60 degrees F nor more than 85 degrees F and a relative humidity of not more than 70 percent shall be maintained before, during, and after installation of acoustical units.

1.6 SCHEDULING

Interior finish work such as plastering, concrete and terrazzo work shall be complete and dry before installation. Mechanical, electrical, and other work above the ceiling line shall be completed and heating, ventilating, and air conditioning systems shall be installed and operating in order to maintain temperature and humidity requirements.

1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided. Standard performance guarantee or warranty shall contain an agreement to repair or replace acoustical panels that fail within the warranty period. Failures include, but are not limited to, sagging and warping of panels; rusting and manufacturers defects of grid system.

1.8 EXTRA MATERIALS

Spare tiles of each color shall be furnished at the rate of [_____] [5] tiles for each 1000 tiles installed. Tiles shall be from the same lot as those installed.

PART 2 PRODUCTS

2.1 ACOUSTICAL UNITS

****

NOTE: Color, pattern, NRC, LR coefficient, CAC, and type of acoustical ceiling units must be shown, as required, on the drawings when more than one type acoustical unit is specified for a project.

Color and pattern must be coordinated with Section 09915 COLOR SCHEDULE, the drawings, and this section when more than one type acoustical unit is specified for a project.

When a specific pattern, as shown in ASTM E 1264 is required, specify the applicable one and delete other patterns; otherwise, specify all patterns as Contractor's options. Ascertain that a specific pattern required is commercially available in the type unit specified since some type units are available only in certain patterns. Specialized patterns must be described in detail within the bracketed blank space.

Acoustical units will be limited generally to Types III and IV. Metal-faced units (Types V, VI, VII, and VIII), and fabric faced overlay (Type XI), because of the higher cost factor, will not normally

be considered.

Minimum ceiling attenuation class (CAC) formerly called ceiling sound transmission class (CSTC), requirement may be modified to minimum CAC rating of 35 or omitted for suspended ceiling systems where room-to-room sound attenuating requirements are less critical or are achieved by other means.

Mineral fiber Type III, IV, IX, and XI acoustical ceiling units offer a combination of rated fire resistance, flame spread classification, acoustical performance, and design versatility. Units are available in a variety of configurations ranging from flat panels with simple textured surfaces to panels with detailed edges or carved patterns and motifs. Cost generally increases with the complexity of design and increase of thickness and/or unit weight.

Fiberglass Type XII acoustical ceiling units are available cloth-faced and vinyl-faced. The fiberglass units have high acoustical performance, thermal insulation value, and moisture resistance ratings. The cloth faced units are good for open-office installations and areas such as libraries that require high acoustical absorption. The vinyl-faced fiberglass units, because of their washable vinyl face, are good for use in buildings with supply and return-air ducts in the ceiling.

Review manufacturer's literature and edit the following paragraphs.
****

Acoustical units shall conform to ASTM E 1264, Class A, and the following requirements:

2.1.1 Units for Exposed-Grid System [A] [_____]

Type: [III (mineral fiber with painted finish)] [IV (mineral fiber with membrane-faced overlay)] [IX (mineral fiber with scrubbable finish)] [XI (mineral fiber with fabric faced overlay)] [XII (fiberglass base with membrane-faced overlay)]. Type [III] [IV] [IX] [XI] acoustical units shall have a minimum recycled material content of 18 percent.

Minimum NRC: [0.55] [_____] when tested on mounting No. E-400

Pattern: [A] [B] [C] [D] [E] [F] [G] [I] [J] [K] [_____].

Nominal size: [24 by 48] [_____] inches.

Edge detail: [Trimmed and butt] [_____].

Finish: Factory-applied [standard finish] [color finish].

Minimum LR coefficient: [0.70] [_____].

Minimum CAC: [40] [_____].

2.1.2   Units for Concealed-Grid System [A] [_____]

Type: [III (mineral fiber with painted finish)] [IV (mineral fiber with membrane-faced overlay)] [IX (mineral fiber with scrubbable finish)]. Acoustical units shall have a minimum recycled material content of 18 percent.

Minimum NRC: [0.55] [_____] when tested on mounting No. E-400.

Pattern: [A] [B] [C] [D] [E] [F] [G] [I] [J] [K] [_____].

Nominal size: [12 by 12] [_____] inches.

Edge detail: [beveled] [square].

Joint detail: [kerfed and rabbeted] [tongue and grooved].

Finish: Factory-applied [standard finish] [color finish].

Minimum LR coefficient: [0.70] [_____].

Minimum CAC: [40] [_____].

2.1.3   Metal Pans [A] [_____]

Type: [V (steel)] [VI stainless steel] [VII (aluminum)] perforated pans with acoustical insulation backing.

Minimum NRC: [0.55] [_____] when tested on mounting No. E-400.

Pattern: [A] [C] [I] [_____].

Nominal size: [24 by 24] [_____] inches.

Edge detail: Manufacturer's standard.

Joint detail: [Beveled] [_____].

Finish: Factory-applied standard finish.

Pads: [Completely enclosed, of material and thickness required for acoustical and fire test ratings] [_____].

Minimum LR coefficient: [0.70] [_____].

2.2   SUSPENSION SYSTEM

****

NOTE: If more than one type of acoustical unit is required, a separate paragraph for that type unit will be used. Each unit type will be designated with a letter or number symbol, such as A, B, etc. Use the same letters or numbers to key unit types to locations listed or shown on the drawings and in Section 09915, COLOR SCHEDULE.

Each different type of suspension system must be shown on the drawings.

An intermediate-duty suspension system should be specified when the minimum load-carrying capacity of the main runner is 175 N per m (12 pounds per linear foot) on a simple span of 1200 mm (4 feet) without the mid-span deflection exceeding 1/360th of the span. Intermediate-duty systems are used primarily for ordinary commercial structures where some ceiling loads, due to light fixtures and air diffusers are anticipated.

A heavy-duty suspension system should be specified when the above described minimum load-carrying capacity is 230 N per m (16 pounds per linear foot). Heavy-duty systems are used when ceiling loads are greater than ordinary commercial construction. See ASTM C 635 for load testing methods for metal suspension systems for acoustical tile and lay-in panel ceilings.

Corner caps are not available in all types of wall moldings and are an extra cost item when available.

Provide seismic details, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase, in the last sentence, if no seismic details are provided.

****

Suspension system shall be [[standard] [fire-resistive]] [[exposed-grid] [concealed-grid]] [[standard width flange] [narrow width flange] [narrow width slotted flange]] [as shown on drawings], and shall conform to ASTM C 635 [for intermediate-duty systems] [for heavy-duty systems]. Surfaces exposed to view shall be [aluminum or steel with a factory-applied [white] [color] baked-enamel finish] [aluminum with a clear anodized finish] [aluminum with colored factory-applied vinyl paint finish]. Wall molding shall have a flange of not less than [15/16 inch] [_____]. [Inside and outside corner caps] [[Standard] [Overlapped] [Mitered] corners] shall be provided. Suspended ceiling framing system shall have the capability to support the finished ceiling, light fixtures, air diffusers, and accessories, as shown. The suspension system shall have a maximum deflection of 1/360 of span length. Seismic details shall conform to the guidance in TI 809-04 and ASTM E 580 [as shown on the drawings].

2.3 HANGERS

****

NOTE: Construction drawings should include a detail drawing showing splayed and countersplayed suspension system hanger wires.

****

Hangers shall be galvanized steel wire. Hangers and attachment shall support a minimum 300 pound ultimate vertical load without failure of supporting material or attachment.

2.4 ACCESS PANELS

Access panels shall match adjacent acoustical units and shall be designed and equipped with suitable framing and fastenings for removal and replacement without damage. Panel shall be not less than 12 by 12 inches or more than 12 by 24 inches. An identification plate of 0.032 inch thick aluminum, 3/4 inch in diameter, stamped with the letters "AP" and finished the same as the unit, shall be attached near one corner on the face of each access panel.

2.5 FIRE RESISTIVE CEILINGS

****

NOTE: Certified laboratory test reports for fire resistance rating and ceiling attenuation class (CAC) cannot be obtained for ceiling assemblies which are nonstandard with the manufacturer. Therefore, where a fire resistance rating and/or ceiling sound transmission class are necessary, do not specify a nonstandard ceiling assembly. Refer to data in the UL Fire Resistance Directory for details.

****

Acoustical ceiling systems indicated as fire resistant shall be rated for fire endurance as indicated when tested in accordance with ASTM E 119. Suspended ceiling shall have been tested with a specimen [roof] [floor] assembly representative of the indicated construction, including mechanical and electrical work within ceiling space openings for light fixtures, and air outlets, and access panels. Ceiling assembly rating shall be [[1] [1-1/2] [2] [3] [4] hour [concealed grid system] [exposed grid system]] [as shown on drawings].

2.6 FINISHES

Acoustical units and suspension system members shall have manufacturer's standard textures, patterns and finishes as specified. Ceiling suspension system components shall be treated to inhibit corrosion.

2.7 COLORS AND PATTERNS

Colors and patterns for acoustical units and suspension system components shall be [as specified in Section 09915 COLOR SCHEDULE] [_____].

2.8 CEILING ATTENUATION CLASS AND TEST

Ceiling attenuation class (CAC) range of acoustical units, when required, shall be determined in accordance with ASTM E 1414. Test ceiling shall be continuous at the partition and shall be assembled in the suspension system in the same manner that the ceiling will be installed on the project. System shall be tested with all acoustical units installed.

PART 3 EXECUTION

3.1 INSTALLATION

Acoustical work shall be provided complete with necessary fastenings, clips, and other accessories required for a complete installation. Mechanical fastenings shall not be exposed in the finished work. Hangers shall be laid out for each individual room or space. Hangers shall be placed to support framing around beams, ducts, columns, grilles, and other penetrations through ceilings. Main runners and carrying channels shall be kept clear of abutting walls and partitions. At least two main runners shall be provided for each ceiling span. Wherever required to bypass an object with the hanger wires, a subsuspension system shall be installed, so that all hanger wires will be plumb.

3.1.1 Suspension System

Suspension system shall be installed in accordance with ASTM C 636 and as specified herein. There shall be no hanger wires or other loads suspended from underside of steel decking.

3.1.1.1 Plumb Hangers

Hangers shall be plumb and shall not press against insulation covering ducts and pipes.

3.1.1.2 Splayed Hangers

****

NOTE: The designer will add a detail to the construction drawings detailing the proper method of splaying and countersplaying hangers when hangers must be splayed (sloped or slanted) around obstructions.

****

Where hangers must be splayed (sloped or slanted) around obstructions, the resulting horizontal force shall be offset by bracing, countersplaying, or other acceptable means.

3.1.2 Wall Molding

Wall molding shall be provided where ceilings abut vertical surfaces. Wall molding shall be secured not more than 3 inches from ends of each length and not more than 16 inches on centers between end fastenings. Wall molding springs shall be provided at each acoustical unit in semi-exposed or concealed systems.

3.1.3 Acoustical Units

****

NOTE: In areas where lay-in ceiling units are subject to pressure differentials between the air plenum above the ceiling and the space below, units will be specified to be held in place with manufacturer's standard hold-down clips.

****

Acoustical units shall be installed in accordance with the approved installation instructions of the manufacturer. Edges of acoustical units shall be in close contact with metal supports, with each other, and in true alignment. Acoustical units shall be arranged so that units less than one-half width are minimized. Units in exposed-grid system shall be held in place with manufacturer's standard hold-down clips, if units weigh less than 1 psf or if required for fire resistance rating.

3.2 CEILING ACCESS PANELS

Ceiling access panels shall be located directly under the items which require access.

3.3 CLEANING

Following installation, dirty or discolored surfaces of acoustical units shall be cleaned and left free from defects. Units that are damaged or improperly installed shall be removed and new units provided as directed.

3.4 RECLAMATION PROCEDURES

****

NOTE: If the job requires removal of acoustical ceiling systems, or acoustical units are left over from new construction, the decision to recycle must be weighed against the cost of packaging and transportation, especially in remote areas. Most mineral fiber ceilings can be recycled. The following ceiling tiles cannot be recycled: 1) Faced materials (vinyl faced, mylar, metal faced). 2) Molded or cast ceiling products and glue up ceiling tiles (either 305 by 305 mm (12 x 12 inches) or 305 by 610 mm (12 by 24 inches) panels). 3) Fiberglass panels. 4) Ceramic based tiles. 5) Some proprietary products.

****

Ceiling tile, designated for recycling by the Contracting Officer, shall be neatly stacked on 4 by 4 foot pallets not higher than 4 foot. Panels shall be completely dry. Pallets shall then be shrink wrapped and symmetrically stacked on top of each other without falling over. Disposal shall be in accordance with Section 02220 DEMOLITION.

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-09650 (July 1996)**
U.S. ARMY CORPS OF ENGINEERS | **----------------------**
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GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 4 (June 1998)
Includes Special Change (Tailoring Options) (June 1998)
Includes Text Adjustment Change (Section 01300 Reference) (June 1997)

Latest Notice change indicated by CHG tags

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Includes Text Adjustment Change (Section 01300 Reference) (June 1997)

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****

SECTION 09650

RESILIENT FLOORING
07/96

****

NOTE: This guide specification covers the requirements for resilient floor coverings and base materials. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for vinyl composition tile, sheet vinyl flooring, solid vinyl tile, rubber flooring, stair, treads, risers, and stringers, resilient base, integral cove base, and feature/transition strip. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****
NOTE: Resilient flooring may be used over wood subfloor provided that the subfloor underside is well ventilated and the installation conforms to the manufacturer's recommendations.

Classifications/grades/types of the tile must be indicated in their proper areas on the drawings if more than one variation is specified. When manufacturer's names, colors, and patterns are shown, add the following note: "Colors listed are for color identification purpose only; the listing is not intended to limit selection of similar colors from other manufacturers." Manufacturer's published data will be checked to ensure that colors, patterns, and sizes selected are available in the thickness selected. Solid color tile are tile with uniform color throughout. Through pattern tile are tile with patterning distributed through the entire thickness.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2240	(1997) Rubber Property - Durometer Hardness
ASTM D 4078	(1992; R 1996) Water Emulsion Floor Polish
ASTM E 648	(1997) Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM E 662	(1995) Specific Optical Density of Smoke Generated by Solid Materials
ASTM F 1066	(1995a) Vinyl Composition Floor Tile
ASTM F 1303	(1997) Sheet Vinyl Floor Covering with Backing
ASTM F 1344	(1993) Rubber Floor Tile
ASTM F 1700	(1996) Solid Vinyl Floor Tile

1.2 FIRE RESISTANCE REQUIREMENTS

****

NOTE: Choice of critical radiant flux level as it applies to building type and area of application will be made in accordance with the latest edition of MIL-HDBK 1008B or NFPA 101. Wherever the use of Class II (0.22) watts finish is required, Class I (0.45) watts will be permitted. Critical radiant flux will be a minimum average of 0.45 watts when used in corridors in bachelor enlisted quarters, bachelor officer quarters, hospital, child care centers, temporary lodging facilities, and new construction detention and correctional facilities. Generally the critical radiant flux will be a minimum of 0.22 for corridors of other type facilities. Where an approved automatic sprinkler system is installed, Class II interior floor finish may be used where Class I floor finish is required, and where Class II is required, no critical radiant flux rating is required. Omit paragraph if not applicable.

****

Flooring in corridors and exits shall have a minimum average critical radiant flux of [0.22] [0.45] watts per square centimeter when tested in accordance with ASTM E 648. The smoke density rating shall be less than 450 when tested in accordance with ASTM E 662.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Resilient Flooring and Accessories; [_____].

Manufacturer's descriptive data and installation instructions including cleaning and maintenance instructions.

SD-09 Reports

Resilient Flooring and Accessories; [_____].

Copies of test reports showing that representative product samples of the flooring proposed for use have been tested by an independent testing laboratory within the past three years or when formulation change occurred and conforms to the requirements specified.

SD-14 Samples

Resilient Flooring and Accessories; [_____].

Three samples of each indicated color and type of flooring and base. Sample size shall be minimum 2-1/2 x 4 inches.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the building site in original unopened containers bearing the manufacturer's name, project identification, and handling instructions. Materials shall be stored in a clean dry area with temperature maintained above 70 degrees F for 2 days prior to installation, and shall be stacked according to manufacturer's recommendations. Materials shall be protected from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances.

1.5 ENVIRONMENTAL REQUIREMENTS

Areas to receive resilient flooring shall be maintained at a temperature above 70 degrees F and below 100 degrees F for 2 days before application, during application and 2 days after application. A minimum temperature of 55 degrees F shall be maintained thereafter.

1.6 SCHEDULING

Resilient flooring application shall be scheduled after the completion of other work which would damage the finished surface of the flooring.

1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

1.8 EXTRA MATERIALS

Extra flooring material of each color and pattern shall be furnished at the rate of[[_____] [5] tiles for each 1000 tiles] [and] [[_____] [5] square feet for each 1000 square feet of sheet flooring] installed. Extra materials shall be from the same lot as those installed. Extra base material composed of 20 linear feet of each color shall be furnished.

PART 2 PRODUCTS

****

NOTE: If more than one type of resilient flooring is required, a separate paragraph for that type floor will be used. Each flooring type will be designated with a letter or number symbol. Use the

same symbols to key flooring types to locations listed or shown on the drawings.
****

2.1   VINYL-COMPOSITION TILE TYPE [A] [_____]

****
NOTE: The 3.2 mm (1/8 inch) thick vinyl composition tile (VCT) should be utilized in high traffic commercial type installations. The 2.4 mm (3/32-inch) thick VCT should be considered for light to medium duty areas such as rooms in BEQ's and BOQ's. But the criteria for selection of any flooring should also consider amount of vehicular traffic (carts, wheelchairs, etc.), abrasiveness of outside soil and exposure to damaging agents.
****

Vinyl-composition tile shall conform to ASTM F 1066, [Class 1, (solid color tile),] [Class 2,(through pattern tile),] Composition 1, asbestos-free, and shall be [12] [_____] inchessquare and [3/32] [1/8] inch thick. Tile shall have the color and pattern uniformly distributed throughout the thickness of the tile. Flooring in any one continuous area shall be from the same lot and shall have the same shade and pattern.

2.2   SHEET VINYL FLOORING TYPE [A] [_____]

****
NOTE: Sheet vinyl flooring should be considered for areas such as health care facilities due to the reduced amount of seams. Seam welded solid vinyl sheet flooring without backing provides a monolithic floor impervious to moisture penetration.
****

Sheet vinyl flooring shall be composed of a homogeneous, vinyl composition. Flooring shall be not less than 72 inches wide. [Sheet vinyl flooring with backing shall conform to ASTM F 1303, [Type II, Grade 1 (minimum wear layer thickness 0.050 inches and minimum overall thickness 0.080 inches.] [Type I, Grade 1, minimum wear layer thickness 0.020 inches and minimum overall thickness of 0.065 inches].] [Sheet vinyl flooring without backing shall meet the overall thickness 0.080 inches, composition, flexibility, indentation, and the solvent resistance requirements of ASTM F 1303, Type II. The solid vinyl color and pattern shall extend through the total thickness of the material.] [High quality vinyl welding rods for heat welding of joints shall be provided.]

2.3   SOLID VINYL TILE TYPE [A] [_____]

Solid vinyl tile shall conform to ASTM F 1700 [Class I] [_____], Type [A] [B]. Tile shall be [9] [12] [16] [18] [_____] inches square by [1/8] [_____] inch thick. Tiles shall be of solid unlaminated construction.

2.4   RUBBER FLOORING TYPE [A] [_____]

****
NOTE: Rubber flooring provides slip resistance not

usually found with other type floor tiles. Consider for areas such as lobbies and ramps. Rubber flooring has a cushioning quality that reduces leg weariness and fatigue. Rubber is not resistant to oil and grease and sometimes performs poorly against certain reagents and stain spills.

The following thicknesses of rubber flooring are recommended for the traffic type shown: 2.0 mm (5/64 inch) thickness - low traffic; 2.8 mm (7/64 inch) thickness - medium traffic; 3.2 mm (1/8 inch) thickness or greater - heavy traffic.

****

2.4.1 Rubber Tile

Rubber tile shall conform to ASTM F 1344 Class 1 homogeneous construction, [Type A (solid color)] [Type B (through mottled)] [12] [_____] inches square. Surface shall be [smooth] [raised [round] [square] [diamond] [minipastille] studs with chamfered edges.] Stud profile shall be [high] [low]. Overall thickness shall be [1/8] [_____] inch thick.

2.4.2 Sheet Rubber Flooring

Sheet rubber shall conform to ASTM F 1344 Class 1 homogeneous construction. [Type A (solid color)] [Type B (through mottled)] 36 inches wide. Surface shall be [smooth] [embossed]. Overall thickness shall be [1/8] [_____] inch thick.

2.5 STAIR TREADS, RISERS, AND STRINGERS

Treads, risers, and stringers shall conform to composition [rubber compounded from a mixture of synthetic and reclaimed rubber. Overall thickness at treads shall be not less than 1/8 inch. Durometer hardness shall be 90, plus or minus 5, when tested in accordance with ASTM D 2240.] [vinyl compounded from virgin polymer or copolymer of vinyl chloride resin, plasticized with phosphate or phthalate esters. Overall thickness shall be not less than 3/32 inch.] Design shall be either a one piece nosing/tread/riser or a two piece nosing/tread with a matching coved riser. Installation shall include stringer angles on both the wall and banister sides, and landing trim. Surface of treads shall be [raised [stud] [rectangle] [diamond] [ribbed] pattern] [[smooth] [smooth with abrasive non-slip inserts]].

2.6 RESILIENT BASE

Base shall be manufacturers standard [rubber] [or] [vinyl], [straight style (installed with carpet)] [coved style (installed with resilient flooring)] [butt toe cove (installed with 1/8 inch thick flooring)]. Base shall be [4] [6] inches high and a minimum 1/8 inch thick. [Preformed outside] [Job Formed] corners shall be furnished.

2.7 INTEGRAL COVED BASE

A [[vinyl] [or] [rubber]] [[square] [round]] cap strip and vinyl, rubber, or wood fillet strip with a minimum radius of 3/4 inch shall be provided for integral coved bases as shown.

2.8   FEATURE STRIP

Feature strips shall be [vinyl] [or] [rubber], 1 inch wide, and of thickness to match the flooring. Color shall be as indicated.

2.9   TRANSITION STRIP

A [vinyl] [or] [rubber] transition strip tapered to meet abutting material shall be provided.

2.10   ADHESIVE

Adhesive for flooring and wall base shall be as recommended by the flooring manufacturer.

2.11   POLISH

Polish shall conform to ASTM D 4078.

2.12   CAULKING AND SEALANTS

Caulking and sealants shall be in accordance with Section 07900 JOINT SEALING.

2.13   MANUFACTURER'S COLOR AND TEXTURE

Color and texture shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

PART 3   EXECUTION

****

NOTE: The surfaces of lightweight concrete slabs tend to be too weak cohesively to support the bond of the adhesives for resilient flooring; therefore, for lightweight concrete floors of less than 1440 kg per cubic meter (90 pcf) density, a 25 mm (1 inch) topping of standard 2400 kg per cubic meter (150 pcf) concrete will be used.

****

3.1   EXAMINATION/VERIFICATION OF CONDITIONS

The Contractor shall examine and verify that site conditions are in agreement with the design package and shall report all conditions that will prevent a proper installation. The Contractor shall not take any corrective action without written permission from the Government.

3.2   SURFACE PREPARATION

Flooring shall be in a smooth, true, level plane, except where indicated as sloped. Before any work under this section is begun, all defects such as rough or scaling concrete, low spots, high spots, and uneven surfaces shall have been corrected, and all damaged portions of concrete slabs shall have been repaired as recommended by the flooring manufacturer. Concrete curing compounds, other than the type that does not adversely affect adhesion, shall be entirely removed from the slabs. Paint, varnish, oils, release agents, sealers, waxers, and adhesives shall be removed, as recommended by the flooring manufacturer.

3.3 MOISTURE TEST

The suitability of the concrete subfloor for receiving the resilient flooring with regard to moisture content shall be determined by a moisture test as recommended by the flooring manufacturer.

3.4 INSTALLATION OF VINYL-COMPOSITION TILE AND SOLID VINYL TILE

Tile flooring shall be installed with adhesive in accordance with the manufacturer's installation instructions. Tile lines and joints shall be kept square, symmetrical, tight, and even. Edge width shall vary as necessary to maintain full-size tiles in the field, but no edge tile shall be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Flooring shall be cut to, and fitted around, all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Edge tile shall be cut, fitted, and scribed to walls and partitions after field flooring has been applied.

3.5 INSTALLATION OF SHEET VINYL FLOORING

Sheet vinyl flooring shall be installed with adhesive in accordance with the manufacturer's written installation instructions. Flooring shall be fitted to the room by hand cutting, straight scribing, or pattern scribing as necessary to suit job conditions. Flooring shall be cut to, and fitted around, all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Seams shall be cut by overlapping or underscribing as recommended by the manufacturer. [Seams and edges of sheet vinyl flooring in room areas [_____] [shown on the drawings] shall be bonded or welded as recommended by the manufacturer.] [Flooring shall be installed with an integral coved base.]

3.6 INSTALLATION OF RUBBER FLOORING

Rubber flooring shall be installed with adhesive in accordance with the manufacturer's written installation instructions. Lines and joints shall be kept square, symmetrical, tight, and even. Edge width shall vary as necessary to maintain full-size [sheets] [tiles] in the field, but no edge pieces shall be less than one-half the field size, except where irregular shaped rooms make it impossible. Flooring shall be cut to, and fitted around, all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Edges shall be cut, fitted, and scribed to walls and partitions after field flooring has been applied.

3.7 INSTALLATION OF FEATURE STRIPS

Edge strips shall be secured with adhesive as recommended by the manufacturer. Edge strips shall be provided at locations where flooring termination is higher than the adjacent finished flooring, except at doorways where thresholds are provided.

3.8 INSTALLATION OF RESILIENT BASE

Wall base shall be installed with adhesive in accordance with the manufacturer's written instructions. Base joints shall be tight and base shall be even with adjacent resilient flooring. Voids along the top edge of base at masonry walls shall be filled with caulk.

3.9 INSTALLATION OF TREADS AND RISERS

Stair treads and risers shall be installed with adhesive in accordance with the manufacturer's written installation instructions. Treads and risers shall cover [the full width of the stairs] [the surface of the stairs to within 6 inches of the edges]. Stairs wider than manufacturer's standard lengths shall have equal length pieces butted together to cover the treads.

3.10 INSTALLATION OF INTEGRAL COVED BASE

Integral coved base shall be formed by extending the flooring material [4] [6] [_____] inches onto the wall surface. Cove shall be supported by a plastic, rubber or wood coved filler having a minimum radius of 3/4 inch. Coved base shall be installed with adhesive in accordance with the manufacturer's written instructions. A metal or vinyl cap strip shall be provided at the top of the base. Voids along the top edge of base at masonry walls shall be filled with caulk.

3.11 CLEANING

Immediately upon completion of installation of tile in a room or an area, flooring and adjacent surfaces shall be cleaned to remove all surplus adhesive. After installation, flooring shall be washed with a cleaning solution, rinsed thoroughly with clear cold water, and, except for raised pattern rubber flooring, rubber tile and sheet rubber flooring, rubber stair treads, and static control vinyl tile, given two coats of polish in accordance with manufacturers written instructions. After each polish coat, floors shall be buffed to an even luster with an electric polishing machine. Raised pattern rubber flooring, rubber tile and sheet rubber flooring, rubber stair treads, and static control vinyl tile shall be cleaned and maintained as recommended by the manufacturer.

3.12 PROTECTION

From the time of laying until acceptance, flooring shall be protected from damage as recommended by the flooring manufacturer. Flooring which becomes damaged, loose, broken, or curled shall be removed and replaced.

-- End of Section --

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SECTION 09680

CARPET

09/96

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****

SECTION 09680

CARPET
09/96

****

NOTE: This guide specification covers the requirements for broadloom and modular tile carpet. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL: http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for broadloom carpet, and modular tile carpet. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

Carpet containing recovered material is designated in 40 CFR 247.12 as an affirmative procurement item. Designers should give preference to products containing recovered material when price, performance, and availability meet project requirements. Polyethylene terephthalate carpet and programs for reprocessing of nylon carpet tiles

offer the opportunity to meet this requirement.
****

PART 1   GENERAL

1.1   REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC TM 16	(1993) Test Method: Colorfastness to Light
AATCC TM 134	(1991) Test Method: Electrostatic Propensity of Carpets
AATCC TM 165	(1993) Test Method: Colorfastness to Crocking: Carpets - AATCC Crockmeter Method
AATCC TM 174	(1993) Test Method: Antimicrobial Activity Assessment of Carpet

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 297	(1993) Rubber Products - Chemical Analysis
ASTM D 418	(1993; R 1997) Pile Yarn Floor Covering Construction
ASTM D 1423	(1992) Twist in Yarns by the Direct-Counting Method
ASTM D 1667	(1997) Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam)
ASTM D 3278	(1996) Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
ASTM D 3676	(1996a) Rubber Cellular Cushion Used for Carpet or Rug Underlay
ASTM E 648	(1997) Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

CARPET AND RUG INSTITUTE (CRI)

CRI 104	(1996) Commercial Carpet Installation Standard

CODE OF FEDERAL REGULATIONS (CFR)

16 CFR 1630	Standard for the Surface Flammability of Carpet and Rugs (FF 1-70)

GERMANY INSTITUTE FOR STANDARDIZATION (DEUTSCHES INSTITUTE FUR NORMUNG) (DIN)

DIN 54318	(1986) Machine-Made Textile Floor Coverings; Determination of Dimensional Changes Due to the Effects of Varied Water and Heat Conditions; Identical with ISO 2551 Edition 1981

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Carpet and Accessories; [_____].

Manufacturer's catalog data and printed documentation stating physical characteristics, durability, resistance to fading, and flame resistance characteristics for each type of carpet material and installation accessory.

SD-04 Drawings

Installation; [_____].

[Three] [_____] copies of drawings indicating areas receiving carpet, carpet types, textures and patterns, direction of pile, location of seams, and locations of edge molding.

SD-06 Instructions

Carpet and Accessories; [_____].

[Three] [_____] copies of the manufacturer's printed installation instructions for the carpet, including preparation of substrate, seaming techniques, and recommended adhesives and tapes.

SD-09 Reports

Moisture and Alkalinity Tests; [_____].

[Three] [_____] copies of test reports of moisture and alkalinity content of concrete slab stating date of test, person conducting the test, and the area tested.

SD-13 Certificates

Carpet and Accessories; [_____].

Certificates of compliance from a laboratory accredited by the National Laboratory Accreditation Program of the National Institute of Standards and Technology attesting that each type of carpet and carpet with cushion material conforms to the standards specified.

SD-14 Samples

Carpet and Accessories; [_____].

a. Carpet: [Two] [_____] "Production Quality" samples 27 x 18 inches of each carpet proposed for use, showing quality, pattern, and color specified.

b. Vinyl or Aluminum Moldings: [Two] [_____] pieces of each type at least 12 inches long.

c. Special Treatment Materials: [Two] [_____] samples showing system and installation method.

SD-19 Operation and Maintenance Manuals

Carpet and Accessories; [_____].

[Three] [_____] copies of carpet manufacturer's maintenance instructions describing recommended type of cleaning equipment and material, spotting and cleaning methods, and cleaning cycles.

1.3 REGULATORY REQUIREMENTS

Carpet and adhesives shall bear the Carpet and Rug Institute (CRI) Indoor Air Quality (IAQ) label. Carpet type bearing the label will indicate that the carpet has been tested and meets the criteria of the CRI IAQ Carpet Testing Program, and minimizes the impact on indoor air quality.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in the manufacturer's original wrappings and packages clearly labeled with the manufacturer's name, brand name, size, dye lot number, and related information. Materials shall be stored in a clean, dry, well ventilated area, protected from damage and soiling, and shall be maintained at a temperature above 60 degrees F for 2 days prior to installation.

1.5 ENVIRONMENTAL REQUIREMENTS

Areas in which carpeting is to be installed shall be maintained at a temperature above 60 degrees F for 2 days before installation, during installation, and for 2 days after installation. A minimum temperature of 55 degrees F shall be maintained thereafter for the duration of the contract. Traffic or movement of furniture or equipment in carpeted area shall not be permitted for 24 hours after installation. Other work which would damage the carpet shall be completed prior to installation of carpet.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one-year period shall be provided.

1.7 EXTRA MATERIAL

Extra material from same dye lot consisting of [full width continuous broadloom] [and] [uncut carpet tiles] shall be provided for future maintenance. A minimum of [_____] percent of total square yards of each carpet type, pattern, and color shall be provided.

PART 2 PRODUCTS

2.1 CARPET TYPE [A] [_____]

****

NOTE: Color, texture, and pattern must be in accordance with Section 09915 COLOR SCHEDULE or must be indicated on the drawings.

If more than one carpet type is required for a project, a separate paragraph CARPET TYPE will be used for each carpet type. Each carpet type will be designated with a letter or number symbol. Use the same symbols to key carpet types to locations listed or indicated on the drawings.

The table below will be used to establish minimum weight/density characteristics of carpet for the moderate, heavy, or severe wear level required. A variety of commonly used pile fibers are listed in this table. Each has different performance characteristics. All are not necessarily satisfactory for all uses. Specifications for each carpet will usually specify the pile fiber that best meets requirements.

Nylon fiber is typically abrasion resistant and durable in all pile configurations using filament fiber, has good stain removal characteristics, and is recommended for the majority of commercial installations. Use only nylon or wool for Air Force projects.

Polypropylene fiber (olefin) resists fading, is chemical, moisture, and stain resistant, gives good wear in the loop pile configuration, and generates

low levels of static electricity. The disadvantages of polypropylene are; it is not easily cleaned, its not as durable as nylon, and it crushes more easily than nylon.

Polyethylene terephthalate (PET) recycled polyester fiber has permanent fade resistance, is permanently colorfast, has a permanent stain resistance which is higher than other type fibers, is impervious to harsh chemicals, and has the lowest static buildup. PET fibers have a very low moisture absorption rate. PET type fibers have a high melting point and PET type carpet is generally preferred over olefin type carpet. PET type polyester carpet, once crushed under continued high pressure, is less likely than nylon carpet to rebound. PET type carpet is not recommended for high (severe) wear level areas such as corridors, elevators, or lobbies but can perform well in Moderate to Heavy wear level areas.

Choice of pile fiber will be governed by the prospective use of the carpet and should be determined by careful evaluation of texture retention, soil hiding, cleanability, abrasion resistance, desired appearance, cost, and other factors applicable to the project.

Wear Level	Nylon Filament	Nylon Staple	Poly Propylene Filament	Wool and Wool/Nylon	Polyethylene terephthalate (PET)
	wt/den	wt/den	Wt/den	wt/den	Wt/den
Moderate					
Loop Pile	20-3200	NR	26-4350	35-3450	NR
Cut Pile	24-3200	24-3600	NR	42-2400	30-4840
Cut/Loop	24-3200	NR	NR	38-3200	NR
Frieze	24-3200	26-3200	NR	38-3200	NR
Woven	22-3300	NR	NR	28-4000	NR
Heavy					
Loop Pile	26-4000	NR	26-6000	40-4500	NR
Cut Pile	32-3600	32-3600	NR	46-4500	45-6480
Cut/Loop	28-4000	NR	NR	45-5000	NR
Frieze	32-3600	32-3600	NR	50-4500	NR
Woven	26-5500	NR	NR	40-4500	NR
Severe					
Loop Pile	26-5500	NR	NR	NR	NR

Wear Level	**Nylon Filament**	**Nylon Staple**	**Poly Propylene Filament**	**Wool and Wool/Nylon**	**Polyethylene terephthalate (PET)**
	wt/den	**wt/den**	**Wt/den**	**wt/den**	**Wt/den**
Cut Pile	**34-4200**	**34-4200**	**NR**	**50-4800**	**NR**
Cut/Loop	**30-5000**	**NR**	**NR**	**NR**	**NR**
Woven	**28-5500**	**NR**	**NR**	**40-5000**	**NR**

NOTE:

1. Yarn weight (wt), or face weight is the ounces per square yard of pile yarn exclusive of the backing.

2. Density (den) is the yarn weight times 36 divided by pile yarn thickness in inches (Density = (w) (36)/T).

3. 80/20 Wool Nylon Blend at wt/den factor 50-4800.

4. (Tufted) = Loop pile, cut pile, cut and loop pile, and frieze.

5. Woven carpet = carpet with surface textures of loop, cut pile, cut and loop, frieze, etc.

6. NR = Not recommended for use in this type wear area.
****

Carpet shall be first quality; free of visual blemishes, streaks, poorly dyed areas, fuzzing of pile yarn, spots or stains, and other physical and manufacturing defects. Carpet materials and treatments shall be reasonably nonallergenic and free of other recognized health hazards. All grade carpets shall have a static control construction which gives adequate durability and performance.

2.1.1 Physical Characteristics

Carpet shall comply with the following:

a. Carpet Construction: [Tufted] [Woven] [Bonded] [_____].

****
NOTE: Carpet width will be stated as the minimum permissible, bearing in mind that wider carpet minimizes the number of seams. The "standard" width for the majority of commercial quality carpet is 3.6 m (12 feet). 1.8 m (Six feet) wide carpet may be cost effective for carpet replacement in occupied spaces.

Modular carpet tiles may also be specified when carpet is authorized by AEI, Design Criteria.
****

b. Type: [Broadloom 12 feet minimum usable carpet width [with exception of corridors] [and] [stairs] [_____].] [Modular tile [18 x 18] [20 x 20] [24 x 24] inches square with 0.15 percent growth/shrink rate in accordance with DIN 54318.]

c. Pile Type: [Level-loop] [Multilevel loop] [Cut and loop] [Frieze] [Cut pile] [Random sheared] [Level tip shear].

d. Pile Fiber: Commercial [branded nylon continuous filament] [branded nylon staple] [[wool] [wool blend] with Wool Bureau certification] [polyethylene terephthalate (PET) 100% recycled fiber] [polypropylene] [_____].

e. Pile or Wire Height: Minimum [_____] inch in accordance with ASTM D 418.

f. Yarn Ply: Minimum [2] [_____] in accordance with ASTM D 1423.

****

NOTE: Omit subparagraphs "g" and "h" if not required.

****

g. Gauge or Pitch: Minimum [_____] inch in accordance with ASTM D 418.

h. Stitches or Rows/Wires: Minimum [_____] per square inch.

i. Finished Pile Yarn Weight: Minimum [_____] ounces per square yard. This does not include weight of backings. Weight shall be determined in accordance with ASTM D 418.

j. Pile Density: Minimum [_____].

k. Dye Method:

****

NOTE: Select dye method required. Solution dyed or yarn dyed is recommended for use in barracks, childcare facilities, cafeteria facilities, and health facilities.

****

[Solution dyed] [Stock dyed] [Yarn (or Skein) dyed] [Piece dyed] [Space dye] [Continuous dye].

l. Backing Materials: Primary backing materials shall be [those customarily used and accepted by the trade for each type of carpet] [polypropylene] [synthetic hardback] [_____]. Secondary backing to suit project requirements shall be those customarily used and accepted by the trade for each type of carpet, except when a special unitary back designed for gluedown is provided.

2.1.2 Performance Requirements

****

NOTE: Specify static control only when required to meet project requirements. Installations for

critical areas such as computer rooms will use the 2.0 kV requirements. Static protected carpets for most commercial installations are normally rated at 3.5 kV.
****

a. Static Control: Static control shall be provided to permanently control static buildup to less than [3.5] [2.0] [_____] kV when tested at 20 percent relative humidity and 70 degrees F in accordance with AATCC TM 134.

****
NOTE: Choice of critical radiant flux level as it applies to building type and area of application will be made in accordance with the latest edition of MIL-HDBK 1008B or NFPA 101. Wherever the use of Class II (0.22) watts finish is required, Class I (0.45) watts will be permitted.

Critical radiant flux will be a minimum average of 0.45 watts when used in corridors in bachelor enlisted quarters, bachelor officer quarters, hospital, child care centers, temporary lodging facilities, and new construction detention and correctional facilities. Generally the critical radiant flux will be a minimum of 0.22 for corridors of other type facilities. Where an approved automatic sprinkler system is installed, Class II interior floor finish may be used where Class I floor finish is required, and where Class II is required, no critical radiant flux rating is required. Omit paragraph if not applicable.
****

b. Flammability and Critical Radiant Flux Requirements: Carpet shall comply with 16 CFR 1630. Carpet in corridors and exits shall have a minimum average critical radiant flux of [0.22] [0.45] watts per square centimeter when tested in accordance with ASTM E 648.

****
NOTE: For most facilities, the 40 N (9 pound) tuft bind for loop pile and 18 N (4 pound) for cut pile are adequate. For child care centers, youth centers, and dependents' schools, specify 53 N (12 pound) tuft bind for loop pile because of the increased potential for loop pull in the course of children's activities. Although increased wear by itself is not the primary factor in damage due to lack of tuft bind, consider 53 N (12 pound) tuft bind for any severe wear application where loop pile might be vulnerable to snagging.
****

c. Tuft Bind: Tuft bind force required to pull a tuft or loop free from carpet backing shall be a minimum [9 pound average force for loop pile] [4 pound average force for cut pile] [_____]

d. Additional Performance Characteristics:

****

NOTE: The following will be specified when required for a specific use, such as dining facilities, child care or hospitals. Delete paragraph unless additional carpet performance characteristics are required to meet particular needs of the specific project.

****

(1) Antimicrobial: Nontoxic antimicrobial treatment in accordance with AATCC TM 174, Part I (qualitative), guaranteed by the carpet manufacturer to last the life of the carpet.

(2) Attached Cushion: Attached cushion shall be [latex foam rubber with minimum weight of 30 oz/sq. yard, minimum thickness of 0.100 inch,minimum density of 17 lb/cubic foot, minimum compression resistance of 5 psi, and maximum compression set of 15 percent in accordance with ASTM D 3676.] [chemically frothed urethane with minimum weight of 18 oz/sq. yard, minimum density of 11 lb/cubic foot] [mechanically frothed urethane with minimum weight of 22 oz/sq. yard, minimum density of 14 lb/cubic foot, minimum thickness of 0.100 inch, and maximum compression resistance of 5 psi, and compression set of 15 percent in accordance with ASTM D 3676.] [[ethylene vinyl acetate (EVA)] [polyvinyl chloride (PVC)] with minimum weight of 28 oz/sq. yard, minimum thickness of 0.150 inch, and minimum density of 15 lb/cubic foot and a maximum compression set of 15 percent in accordance with ASTM D 1667.] Maximum ash content shall not exceed 50 percent when tested in accordance with ASTM D 297. Cushion shall pass accelerated aging test in accordance with ASTM D 3676.

e. Colorfastness to Crocking: Dry and wet crocking shall comply with AATCC TM 165 and shall have a minimum rating of step 4 on the AATCC Color Transference Chart for all colors.

f. Colorfastness to Light: Colorfastness to light shall comply with AATCC TM 16 and shall have a minimum 4 grey scale rating after 40 hours.

g. Delamination Strength: Delamination strength for tufted carpet with a secondary back shall be minimum of 2.5 lb./inch

2.2 ADHESIVES AND CONCRETE PRIMER

Adhesives and concrete primers for installation of carpet shall be waterproof, nonflammable, meet local air-quality standards, and shall be as recommended by the carpet manufacturer. Seam adhesive shall be waterproof, nonflammable, and nonstaining as recommended by the carpet manufacturer. Release adhesive for modular tile carpet shall be as recommended by the carpet manufacturer. Adhesives flashpoint shall be minimum 140 degrees F in accordance with ASTM D 3278.

2.3 MOLDING

[Aluminum molding shall be a hammered surface, pinless clamp-down type, designed for the type of carpet being installed. Finish shall be [natural color anodized] [prefinished color [_____]]. Floor flange shall be a minimum 1-1/2 inches wide and face shall be a minimum 5/8 inch wide. [Vinyl molding shall be heavy-duty and designed for the type of carpet being installed. Floor flange shall be a minimum 2 inches wide.] Color shall be [_____].]

2.4 TAPE

Tape for seams shall be as recommended by the carpet manufacturer for the type of seam used in installation.

2.5 COLOR, TEXTURE, AND PATTERN

Color, texture, and pattern shall be [in accordance with Section 09915COLOR SCHEDULE] [_____].

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Carpet shall not be installed on surfaces that are unsuitable and will prevent a proper installation. Holes, cracks, depressions, or rough areas shall be repaired using material recommended by the carpet or adhesive manufacturer. Floor shall be free of any foreign materials and swept broom clean. Before beginning work, subfloor shall be tested with glue and carpet to determine "open time" and bond.

3.2 MOISTURE AND ALKALINITY TEST

Concrete slab shall be tested for moisture content and excessive alkalinity in accordance with CRI 104. The moisture content shall not exceed a hygrometer reading of 65 percent.

3.3 PREPARATION OF CONCRETE SUBFLOOR

****

NOTE: Designer must coordinate need for sealing of concrete slab with project requirements such as wet conditions which might occur in hospital care.

****

Installation of the carpeting shall not commence until concrete substrate is at least 90 days old. The concrete surfaces shall be prepared in accordance with instructions of the carpet manufacturer. Type of concrete sealer, when required, shall be compatible with the carpet.

3.4 INSTALLATION

Installation shall be in accordance with the manufacturer's instructions and CRI 104. Edges of carpet meeting hard surface flooring shall be protected with molding. Installation shall be in accordance with the molding manufacturer's instructions.

3.4.1 Broadloom Installation

Broadloom carpet shall be installed [direct glue down] [pre-applied adhesive glue down] and shall be smooth, uniform, and secure, with a minimum of seams. Seams shall be uniform, unnoticeable, and treated with a seam adhesive. Side seams shall be run toward the light where practical and where such layout does not increase the number of seams. Breadths shall be installed parallel, with carpet pile in the same direction. Patterns shall be accurately matched. Cutouts, as at door jambs, columns and ducts shall be neatly cut and fitted securely. Seams at doorways shall be located parallel to and centered directly under doors. Seams shall not be made perpendicular to doors or at pivot points. Seams at changes in directions of corridors shall follow the wall line parallel to the carpet direction. Corridors with widths less than 6 feet shall have the carpet laid lengthwise down the corridors.

3.4.2 Modular Tile Installation

Modular tiles shall be installed with [permanent vinyl-compatible] [release] adhesive and shall be snugly jointed together. Tiles shall be laid in [the same direction] [an alternating pattern] with accessibility to the subfloor where required.

3.5 CLEANING AND PROTECTION

3.5.1 Cleaning

After installation of the carpet, debris, scraps, and other foreign matter shall be removed. Soiled spots and adhesive shall be removed from the face of the carpet with appropriate spot remover. Protruding face yarn shall be cut off and removed. Carpet shall be vacuumed clean.

3.5.2 Protection

The installed carpet shall be protected from soiling and damage with heavy, reinforced, nonstaining kraft paper, plywood, or hardboard sheets. Edges of kraft paper protection shall be lapped and secured to provide a continuous cover. Traffic shall be restricted for at least 45 hours. Protective covering shall be removed when directed by the Contracting Officer.

3.6 REMNANTS

Remnants remaining from the installation, consisting of scrap pieces more than 2 feet in dimension with more than 6 square feet total, shall be provided. Non-retained scraps shall be removed from site.

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-09840 (January 1998)**
U.S. ARMY CORPS OF ENGINEERS | **-------------------------**
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SECTION 09840

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01/98

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SECTION 09840

ACOUSTICAL WALL TREATMENT
01/98

****

NOTE: This guide specification covers the requirements for fabric covered acoustical wall panel systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL: http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC TM 16	(1993) Test Method: Colorfastness to Light

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 423	(1990a) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM D 1117	(1997) Nonwoven Fabrics
ASTM D 5034	(1995) Breaking Strength and Elongation of Textile Fabrics (Grab Test)
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO-Bldg Code	(1997) Uniform Building Code (3 Vol)

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Acoustical Wall Panels; [_____].

Manufacturer's descriptive data and catalog cuts.

SD-04 Drawings

Acoustical Wall Panels; [_____].

Drawings showing plan locations, elevations and details. Drawings shall include details of method of anchorage, location of doors and other openings, base detail and shape and thickness of materials.

SD-06 Instructions

Acoustical Wall Panels; [_____].

Manufacturer's installation instructions and recommended cleaning instructions.

SD-13 Certificates

Acoustical Wall Panels; [_____].

Certificates of compliance from an independent laboratory accredited by the National Laboratory Accreditation Program of the National Institute of Standards. A label or listing from the testing laboratory will be acceptable evidence of compliance.

SD-14 Samples

Acoustical Wall Panels; [_____].

Manufacturer's standard fabric swatches, minimum 18 inches wide by 24 inches long [2] [_____] samples of each color range specified.

1.3 DELIVERY AND STORAGE

Materials delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt, dust, or other contaminants.

1.4 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

PART 2 PRODUCTS

2.1 FABRIC COVERED ACOUSTICAL WALL PANELS

****

NOTE: Drawings must show locations and dimensions of acoustical panels, details of joints, base, head, and mounting details.

The same or similar acoustical benefits can possibly be obtained by other means such as wall covering, etc.

Omit the following items that do not meet project requirements.

****

Acoustical wall panels shall consist of prefinished factory assembled, seamless fabric covered, fiber glass or mineral fiber core system as described below. Wall panels shall be manufactured to the dimensions and configurations shown on the drawings. Perimeter edges shall be [non-reinforced.] [reinforced by either an aluminum frame or a formulated resin edge hardener.] Acoustical wall panels installed in non-sprinklered areas must comply with the requirements of ICBO Bldg Code, Standard 42-2.

a. Panel Width: [Widths shall be [24] [30] [48] [60] inches] [End panels may vary in width as necessary to cover wall] [Panel width shall be as detailed.]

b. Panel Height: [Heights shall be [96] [108] [120] inches.] [[Panels shall be field measured for custom fit to ceiling.] [Tolerance at floor to be as detailed].] [Panel height shall be as detailed.]

c. Thickness: [Panel thickness shall be as required to meet the indicated NRC range] [_____].

d. Fabric Covering: Seamless [non-woven, embossed texture, needle punched 100 percent polyester, minimum 11 ounces per linear yard. Tear strength shall be minimum 25 pounds machine direction and minimum 40 poundscross-machine direction in accordance with ASTM D 1117. Tensile strength shall be minimum 50 pounds machine direction and minimum 75 pounds cross-machine direction in accordance with ASTM D 5034.] [plain woven 2-ply 100 percent polyester, minimum 15 ounces per linear yard. Tear strength shall be minimum 29 pounds. Tensile strength shall be 150 pounds minimum in accordance with ASTM D 5034.] [perforated vinyl covering with fabric backing, minimum 20 ounces per linear yard total weight.] Fabric covering shall be stretched free of wrinkles and then bonded to the edges and back or bonded directly to the panel face, edges, and back of panel a minimum distance standard with the manufacturer. Light fastness (fadeometer) shall be approximately 40 hours in accordance with AATCC TM-16.

e. Fire rating for the complete composite system: Class A, 200 or less smoke density and flame spread less than 25, when tested in accordance with ASTM E 84.

f. Substrate: Fiber glass or mineral fiber.

g. Noise Reduction Coefficient (NRC) Range: [0.50-0.60] [0.80-0.90] [_____] ASTM C 423.

h. Edge Detail: [Half bevel] [Bevel] [Radius] [Square] [Mitered] [_____] edge.

i. Core Type: [Standard acoustical] [High impact acoustical] [Acoustical/tackable] [_____] core.

J. Mounting: Acoustical panels shall be mounted by manufacturer's standard [concealed spline] [mechanical fasteners] [magnetic fasteners] [hook and loop] [adhesive mounting] [_____].

k. Color: Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

Walls shall be clean, smooth, oil free and prepared in accordance with panel manufacturer's instructions. Installation shall not begin until all wet work, such as, plastering, painting, and concrete are completely dry.

3.2 INSTALLATION

Panel installation shall be by personnel familiar with and normally engaged in installation of acoustical wall panels. Panels shall be applied in accordance with the manufacturer's installation instructions.

3.3 CLEANING

Following installation, dirty or stained panel surfaces shall be cleaned in accordance with manufacturer's instructions and left free from defects. Panels that are damaged, discolored, or improperly installed shall be removed and new panels provided as directed.

-- End of Section --

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07/92

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SECTION 09900

PAINTING, GENERAL
07/92

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NOTE: This guide specification covers the requirements for painting of interior and exterior substrates, including masonry, metals and woods. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH Limit Values	(1996) Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 150	(1997) Portland Cement
ASTM D 3273	(1994) Resistance to Growth of Mold on the Surface of Interior Coating in an Environmental Chamber
ASTM D 3274	(1995) Evaluating Degree of Surface Disfigurement of Paint Films by Microbial (Fungal or Algal) Growth or Soil and Dirt Accumulation
ASTM D 4214	(1998) Evaluating Degree of Chalking of Exterior Paint Films
ASTM D 4258	(1999) Surface Cleaning Concrete for Coating

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1500	(Rev A; Notice 1) Sealer, Surface (Latex Block Filler)
CID A-A-1546	(Rev A) Rubbing Varnish
CID A-A-1632	(Basic) Varnish, Asphalt
CID A-A-1788	(Basic) Varnish, Oil: Interior
CID A-A-2246	(Rev B) Paint, Latex
CID A-A-2247	(Basic) Paint, Latex (Semigloss, Interior)
CID A-A-2248	(Basic) Paint, Latex, (Flat, Interior)
CID A-A-2335	(Basic) Sealer, Surface (Varnish Type, Wood and Cork Floors)
CID A-A-2336	(Rev A) Primer Coating (Alkyd, Exterior Wood, White and Tints)
CID A-A-2339	(Basic) Stain (Wood, Solvent-Dye Type)
CID A-A-2542	(Basic) Sealer, Terrazzo and Concrete Floors, Waterbased
CID A-A-2834	(Basic) Urethane, Waterborne (Low VOC, Clear)

CID A-A-2867	(Basic) Coating, Polyurethane, Single Component Moisture Cure, Alipathic
CID A-A-2962	(Rev A) Enamel, Alkyd (Metric)
CID A-A-2994	(Basic) Primer Coating, Interior, for Walls and Wood

FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 70/7460-1	(Rev J) Obstruction Marking and Lighting

FEDERAL SPECIFICATIONS (FS)

FS TT-C-542	(Rev E) Coating, Polyurethane, Oil-Free, Moisture Curing
FS TT-C-555	(Rev B; Am 1) Coating, Textured (for Interior and Exterior Masonry Surfaces)
FS TT-E-2784	(Rev A) Enamel (Acrylic-Emulsion, Exterior Gloss and Semigloss) (Metric)
FS TT-P-28	(Rev G; Notice 1) Paint, Aluminum, Heat Resisting (1200 Degrees F.)
FS TT-S-708	(Rev A; Am 2; Notice 1) Stain, Oil; Semi-Transparent, Wood, Exterior
FS TT-S-001992	(Basic; Notice 1) Stain, Latex, Exterior for Wood Surfaces

MAPLE FLOORING MANUFACTURERS ASSOCIATION (MFMA)

MFMA-03	(1997) Floor Sealer andFinish List and Specifications for Heavy Duty and Gymnasium Sealers and Finishes for Maple, Beech and Birch Floors: MFMA Floor Finish List Number 16

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 5	(1995) Zinc Dust, Zinc Oxide and Phenolic Varnish Paint
SSPC Paint 18	(1991) Chlorinated Rubber Intermediate Coat Paint
SSPC Paint 20	(1991) Zinc-Rich Primers (Type I - Inorganic and Type II - Organic)
SSPC Paint 23	(1982) Latex Primer for Steel surfaces
SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)
SSPC SP 1	(1982) Solvent Cleaning

SSPC SP 2	(1995) Hand Tool Cleaning
SSPC SP 3	(1995) Power Tool Cleaning
SSPC SP 6/NACE 3	(1994) Commercial Blast Cleaning
SSPC SP 7/NACE 4	(1994) Brush-Off Blast Cleaning

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Paint; [_____].

The names, quantity represented, and intended use for the proprietary brands of materials proposed to be substituted for the specified materials [when the required quantity of a particular batch is 50 gallons or less.] [regardless of quantities in states where VOC content limitations apply.]

SD-06 Instructions

Mixing and Thinning; [_____]. Application; [_____].

Manufacturer's current printed product description, material safety data sheets (MSDS) and technical data sheets for each coating system. Detailed mixing, thinning and application instructions, minimum and maximum application temperature, and curing and drying times between coats for epoxy, moisture-curing polyurethane, and liquid glaze coatings. Detailed application instructions for textured coatings shall be provided.

SD-09 Reports

Paint; [_____].

A statement as to the quantity represented and the intended use, plus the following test report for batches in excess of 50 gallons:

a. A test report showing that the proposed batch to be used meets specified requirements:

b. A test report showing that a previous batch of the same formulation as the batch to be used met specified requirements, plus, on the proposed batch to be used, a report of test results for properties of weight per gallon, viscosity, fineness of grind, drying time, color, and gloss.

SD-13 Certificates

Lead; [_____]. Mildewcide and Insecticide; [_____]. Volatile Organic Compound (VOC) Content; [_____].

Certificate stating that paints for interior use contain no mercurial mildewcide or insecticide. Certificate stating that paints proposed for use contain not more than 0.06 percent lead by weight of the total nonvolatile. Certificate stating that paints proposed for use meet Federal VOC regulations and those of the of the local Air Pollution Control Districts having jurisdiction over the geographical area in which the project is located.

SD-14 Samples

Moisture-Curing Polyurethane; [_____].

A complete moisture-curing polyurethane system applied to a panel of the same material as that on which the coating will be applied in the work and for each color specified. The sample panels will be used for quality control in applying the system.

Paint; [_____].

While the material is at the site or source of supply, and at a time agreeable to the Contractor and the Contracting Officer, a 1 quart sample of each color and batch, except for quantities of 50 gallons or less, shall be taken by random selection from the sealed containers by the Contractor in the presence of a representative of the Contracting Officer. The contents of the containers to be sampled shall be thoroughly mixed to ensure that the sample is representative. Samples shall be identified by designated name, specification number, manufacturer name and address, batch number, project contract number, intended use, and quantity involved.

1.3 PACKAGING, LABELING, AND STORING

Paints shall be in sealed containers that legibly show the designated name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer. Pigmented paints shall be furnished in containers not larger than 5 gallons. Paints and thinner shall be stored in accordance with the manufacturer's written directions and as a minimum stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors and at temperatures between 40 and 95 degrees F. Paints shall be stored on the project site or segregated at the source of supply sufficiently in advance of need to allow 30 days for testing.

1.4 APPROVAL OF MATERIALS

****

NOTE: Although provision is made for obtaining test reports, the importance of Government testing of

each batch is emphasized when quantities of 200 liters (50 gallons) or more are involved in general painting. For quantities less than 200 liters (50 gallons), the factors of time, value of material versus cost of testing, and the end use of material may justify acceptance on the basis of test reports furnished. The requirements for Contractor test report responsibilities may be modified to exempt materials that will definitely be tested.

Many oil base and latex paints, whether submitted for compliance with Government specifications or as proprietary materials can be field evaluated by the Contracting Officer using a CERL Paint Test Kit. The kit provides a rapid, economical method for screening paints, thereby reducing the need for complete laboratory testing. Paints for which the kit is suitable include:

	CID A-A-3067
CID A-A-2246	
CID A-A-2247	**CID A-A-2336**
CID A-A-2248	**FS TT-E-2784**

****

When samples are tested, approval of materials will be based on tests of the samples; otherwise, materials will be approved based on test reports furnished with them. If materials are approved based on test reports furnished, samples will be retained by the Government for testing should the materials appear defective during or after application. In addition to any other remedies under the contract the cost of retesting defective materials will be at the Contractor's expense.

1.5 ENVIRONMENTAL CONDITIONS

Unless otherwise recommended by the paint manufacturer, the ambient temperature shall be between 45 and 95 degrees F when applying coatings other than water-thinned, epoxy, and moisture-curing polyurethane coatings. Water-thinned coatings shall be applied only when ambient temperature is between 50 and 90 degrees F. Epoxy, and moisture-curing polyurethane coatings shall be applied only within the minimum and maximum temperatures recommended by the coating manufacturer. Moisture-curing polyurethane shall not be applied when the relative humidity is below 30 percent.

1.6 SAFETY AND HEALTH

Work shall comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in the CONTRACT CLAUSES. The Activity Hazard Analysis shall include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1.6.1 Worker Exposures

Exposure of workers to hazardous chemical substances shall not exceed limits established by ACGIH Limit Values, or as required by a more stringent applicable regulation.

1.6.2 Toxic Compounds

Toxic products having ineffective physiological warning properties, such as no or low odor or irritation levels, shall not be used unless approved by the Contracting Officer.

1.6.3 Training

Workers having access to an affected work area shall be informed of the contents of the applicable material data safety sheets (MDSS) and shall be informed of potential health and safety hazard and protective controls associated with materials used on the project. An affected work area is one which may receive mists and odors from the painting operations. Workers involved in preparation, painting and clean-up shall be trained in the safe handling and application, and the exposure limit, for each material which the worker will use in the project. Personnel having a need to use respirators and masks shall be instructed in the use and maintenance of such equipment.

1.6.4 Coordination

Work shall be coordinated to minimize exposure of building occupants, other Contractor personnel, and visitors to mists and odors from preparation, painting and clean-up operations.

PART 2 PRODUCTS

2.1 PAINT

The term "paint" as used herein includes emulsions, enamels, paints, stains, varnishes, sealers, cement-emulsion filler, and other coatings, whether used as prime, intermediate, or finish coat. Paint shall conform to the requirements listed in the painting schedules at the end of this section, except when the required amount of a material of a particular batch is 50 gallons or less, an approved first-line proprietary paint material with similar intended formulation, usage and color to that specified may be used. Additional requirements are as follows:

2.1.1 Colors and Tints

Colors shall be as selected from manufacturer's standard colors, as indicated. Manufacturer's standard color is for identification of color only. Tinting of epoxy and urethane paints shall be done by the manufacturer. Stains shall conform in shade to manufacturer's standard color. The color of the undercoats shall vary slightly from the color of the next coat.

2.1.2 Mildewcide and Insecticide

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NOTE: Paints used on surfaces in areas of high humidity where mildew is possible and on fabric or vapor barrier over insulation will contain a biocide.

****

Paint specified for all coats applied to fabrics and vapor barrier jackets over insulation and surfaces in [_____] area shall contain a mildewcide that will not adversely affect the color, texture, or durability of the coating. The mildewcide shall be incorporated into the paint by the manufacturer and shall attain a surface disfigurement rating of 8 or greater when tested in accordance with ASTM D 3273 and evaluated in accordance with ASTM D 3274. Mercurial mildewcide shall not be used in interior paint. Insecticides shall not be used in paint.

2.1.3 Lead

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NOTE: Current laws define lead-based paint as any paint containing more than 0.06 percent lead by weight (calculated as lead metal) in the total nonvolatile content of the paint, or the equivalent measure of lead in the dried film of paint already applied.

****

Paints containing lead in excess of 0.06 percent by weight of the total nonvolatile content (calculated as lead metal) shall not be used.

2.1.4 Chromium

Paints containing zinc chromate or strontium chromate pigments shall not be used.

2.1.5 Volatile Organic Compound (VOC) Content

****

NOTE: The Federal Clean Air Act requires each state to meet the National Ambient Air Quality Standards. In addition, each state or local government may impose more restrictive requirements. Therefore, the designer should determine the local restrictions and eliminate prohibited materials. It may be necessary to specify locally available commercial products which have been developed to meet local restrictions.

****

Paints shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards and shall conform to the restrictions of the local air pollution control authority.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS NOT TO BE PAINTED

Items not to be painted which are in contact with or adjacent to painted surfaces shall be removed or protected prior to surface preparation and painting operations. Items removed prior to painting shall be replaced when painting is completed. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Surfaces contaminated by coating materials shall be restored to original condition.

3.2 SURFACE PREPARATION

Surfaces to be painted shall be clean and free of foreign matter before application of paint or surface treatments. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primmed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

3.2.1 Concrete, Stucco and Masonry Surfaces

Concrete, stucco and masonry surfaces shall be allowed to dry at least 30 days before painting, except concrete slab on grade which shall be allowed to cure 90 days before painting. Surfaces shall be cleaned in accordance with ASTM D 4258. Glaze, efflorescence, laitance, dirt, grease, oil, asphalt, surface deposits of free iron and other foreign matter shall be removed prior to painting. Surfaces to receive polyurethane or epoxy coatings shall be acid-etched or mechanically abraded as specified by the coating manufacturer, rinsed with water, allowed to dry, and treated with the manufacturer's recommended conditioner prior to application of the first coat.

3.2.2 Ferrous Surfaces

Ferrous surfaces including those that have been shop-coated, shall be solvent-cleaned or detergent-washed in accordance with SSPC SP 1. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be cleaned mechanically with hand tools according to SSPC SP 2, power tools according to SSPC SP 3 or by sandblasting according to SSPC SP 7/NACE 4. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

3.2.3 Nonferrous Metallic Surfaces

Galvanized, aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces shall be solvent-cleaned or detergent-washed in accordance with SSPC SP 1.

3.2.4 Gypsum Board Surfaces

Gypsum board surfaces shall be dry and shall have all loose dirt and dust removed by brushing with a soft brush, rubbing with a cloth, or vacuum-cleaning prior to application of the first-coat material. A damp cloth or sponge may be used if paint will be water-based.

3.2.5 Mastic-Type Surfaces

Mastic-type surfaces shall be prepared by removing foreign material.

3.2.6 Plaster Surfaces

Plaster shall age at least 30 days before painting. Plaster shall be clean and free from loose matter and shall have an instrument-measured moisture content not exceeding 8 percent.

3.2.7 Wood Surfaces

Wood surfaces shall be cleaned of foreign matter. Moisture content of the wood shall not exceed 12 percent as measured by a moisture meter, unless otherwise authorized. Wood surfaces adjacent to surfaces to receive water-thinned paints shall be primed and/or touched up before applying water-thinned paints. Small, dry seasoned knots shall be scraped, cleaned, and given a thin coat of commercial knot sealer, before application of the priming coat. Pitch on large, open, unseasoned knots and all other beads or streaks of pitch shall be scraped off, or, if it is still soft, removed with mineral spirits or turpentine, and the resinous area shall be thinly coated with knot sealer. Finishing nails shall be set, and all holes and surface imperfections shall be primed. After priming, holes and imperfections in finish surfaces shall be filled with putty or plastic wood filler, colored to match the finish coat if natural finish is required, allowed to dry, and sanded smooth. Putty or wood filler shall be compatible with subsequent coatings.

3.2.7.1 Interior Wood Stain

Interior wood surfaces to receive stain shall be sanded. Oak and other open-grain wood to receive stain shall be given a coat of wood filler not less than 8 hours before the application of stain; excess filler shall be removed and the surface sanded smooth.

3.2.7.2 Sanding of Wood Floors

Sanding of wood floors is specified in Section 09640 WOOD STRIP FLOORING. Floors of oak or similar open-grain wood shall be filled with wood filler recommended by the finish manufacturer and the excess filler removed.

3.2.8 Previously Painted Surfaces

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NOTE: Delete inapplicable phrases or delete entire paragraph if no previously painted surfaces will be encountered.
****

Previously painted surfaces [specified to be repainted] [damaged during construction] shall be thoroughly cleaned of all grease, dirt, dust or other foreign matter. Blistering, cracking, flaking and peeling or other deteriorated coatings shall be removed. Slick surfaces shall be roughened. Damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls shall be repaired with suitable material to match adjacent undamaged areas. Edges of chipped paint shall be feather edged and sanded smooth. Rusty metal surfaces shall be cleaned as per SSPC requirements. Solvent, mechanical, or chemical cleaning methods shall be used to provide surfaces suitable for painting. Chalk shall be removed so that when tested in accordance with ASTM D 4214, the chalk resistance rating is no less than 8. New, proposed coatings shall be compatible with existing coatings. If existing surfaces are glossy, the gloss shall be reduced.

3.3 MIXING AND THINNING

When thinning is approved as necessary to suit surface, temperature, weather conditions, or application methods, paints may be thinned in accordance with the manufacturer's directions. When thinning is allowed, paints shall be thinned immediately prior to application with not more than 1 pint of suitable thinner per gallon. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

3.3.1 Cement-Emulsion Filler Coat

Cement and aggregate shall be dry-mixed so that uniform distribution and intermixing are obtained. Mixing liquid and one-half of the total amount of water shall be premixed and added gradually to the white portland cement and aggregate with constant stirring until a thick, smooth material is obtained. Emulsion paint shall then be added to the mixture and stirred until uniformity is obtained. The blend shall have a thick, creamy consistency. The remainder of the water shall be added if necessary to obtain a material with adequate application properties. Blending resin emulsion or emulsion paint with any other component shall be done with caution; too rapid an agitation will cause air entrapment and foaming.

3.3.2 Two-Component Systems

Two-component systems shall be mixed in accordance with manufacturer's instructions. Any thinning of the first coat to ensure proper penetration and sealing shall be as recommended by the manufacturer for each type of substrate.

3.4 APPLICATION

Painting practices shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application. Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces. Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

3.4.1 Ventilation

Affected areas shall be ventilated during paint application so that workers exposure to chemical substances shall not exceed limits as established by ACGIH Limit Values, or as required by a more stringent applicable regulation. Interior work zones having a volume of 10,000 cubic feet or less shall be ventilated at a minimum of 2 air exchanges per hour. Ventilation in larger work zones shall be maintained by means of mechanical exhaust. Solvent vapors shall be exhausted outdoors, away from air intakes and workers. Return air inlets in the work zone shall be temporarily sealed before start of work until the coatings have dried.

3.4.2 Respirators

Operators and personnel in the vicinity of operating paint sprayers shall wear respirators.

3.4.3 First Coat

The first coat on plaster, gypsum wallboard, and other surfaces shall include repeated touching up of suction spots or overall application of primer or sealer to produce uniform color and gloss. Excess sealer shall be wiped off after each application. The first coat on both faces of wood doors shall be applied at essentially the same time. Glazed doors and sashes shall be given the specified coating system within 3 weeks of the time they are glazed, but not before the glazing material has set; paint shall overlay glass about 70 mils all around. Each varnish coat shall be sanded lightly prior to application of subsequent coats.

3.4.4   Timing

Surfaces that have been cleaned, pretreated, and otherwise prepared for painting shall be given a coat of the specified first coat as soon as practical after such pretreatment has been completed, but prior to any deterioration of the prepared surface. Sufficient time shall elapse between successive coats to permit proper drying. This period shall be modified as necessary to suit weather conditions. Oil-based or oleoresinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause the undercoat to lift or lose adhesion. Manufacturer's instructions for application, curing and drying time between coats of two-component systems shall be followed.

3.4.5   Stains

Stain shall be applied at the rate specified in the manufacturer's printed directions. Oil-type stain shall be applied by brushing with the grain for the full length of the board or course of siding.

3.4.6   Fillers

Concrete and masonry surface voids shall be filled; however, surface irregularities need not be completely filled. The dried filler shall be uniform and free of pinholes. Filler shall not be applied over caulking compound.

3.4.6.1   Cement-Emulsion Filler

Immediately before filler application, surfaces shall be dampened uniformly and thoroughly, with no free surface water visible, by several applications of potable water with a fog spray, allowing time between the sprayings for water to be absorbed. Cement-emulsion filler shall be scrubbed into the surface vigorously with a stiff-bristled brush having tampico or palmyra bristles not longer than 2-1/2 inches. At least 24 hours shall elapse before applying exterior emulsion paint over cement-emulsion filler. When the ambient temperature is over 85 degrees F, cement-emulsion filler surfaces shall be dampened lightly with a fog spray of potable water immediately prior to application of the subsequent paint coat.

3.4.6.2   Latex Filler

Latex filler, CID A-A-1500, shall be applied according to the manufacturer's instructions. Surface voids shall be filled and excess filler shall be removed from the surface with a rubber squeegee. The filler shall be allowed to dry the length of time specified by the manufacturer prior to applying successive coats of paint.

3.4.7   Textured Coating

Application of textured coating, FS TT-C-555, shall be as specified in the manufacturer's printed directions.

3.4.8   Ferrous-Metal Primer

Primer for ferrous-metal shall be applied to ferrous surfaces to receive paint other than asphalt varnish prior to deterioration of the prepared surface. The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.

3.5   PIPE COLOR CODE MARKING

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NOTE: Piping identification specified is based on ANSI A 13.1. Pipe carrying materials not listed in TABLE I will be added in accordance with ANSI A 3.1.

Designer will fill in the blanks with the highest probable working pressure in the hydraulic fluid piping.

****

Pipes in exposed areas and in accessible pipe spaces shall be provided with color band and titles adjacent to all valves, except those provided at plumbing fixtures, at not more than 40 foot spacing on straight pipe runs, adjacent to change in direction, and on both sides where pipes pass through walls or floors. Color code marking shall be of the color listed in TABLE I and the size listed in TABLE II. The arrows shall be installed adjacent to each band to indicate the direction of flow in the pipe. The legends shall be printed in upper-case black letters as listed in TABLE I. Letter sizes shall be as listed in TABLE II. Marking shall be painted or applied using colored, pressure-sensitive adhesive markers of standard manufacture. Paint shall be as specified for insulated and uninsulated piping.

TABLE I. COLOR CODES FOR MARKING PIPE

Material	Band	Letters and Arrow*	Legend
Cold water (potable)	Green	White	POTABLE WATER
Fire protection water	Red	White	FIRE PR. WATER
Fire Sprinkler Water	Red	White	FIRE SPR. WATER
Hot water (domestic)	Green	White	H.W.
Hot water recirculating (domestic)	Green	White	H.W.R.
High temp. water supply	Yellow	Black	H.T.W.S.
High temp. water return	Yellow	Black	H.T.W.R.
Boiler feed water	Yellow	Black	B.F.
Low temp. water supply (heating)	Yellow	Black	L.T.W.S.
Low temp. water return (heating)	Yellow	Black	L.T.W.R.
Condenser water supply	Green	White	COND. W.S.
Condenser water return	Green	White	COND. W.R.
Chilled water supply	Green	White	C.H.W.S.
Chilled water return	Green	White	C.H.W.R.
Treated water	Green	White	TR. WATER
Chemical feed	Yellow	Black	CH. FEED

TABLE I. COLOR CODES FOR MARKING PIPE

Material	Band	Letters and Arrow*	Legend
Compressed air	Blue	White	COMP. AIR
Natural gas	Yellow	Black	NAT. GAS
Propane Gas	Yellow	Black	PROP. GAS
Refrigerants	Blue	White	REFRIGERANT
Fuel oil	Yellow	Black	FUEL OIL
Steam	Yellow	Black	STEAM
Condensate	Yellow	Black	CONDENSATE
Hydraulic fluid under 600 psi	Green	White	HYDRAULIC FLUID-_____PSI
Hydraulic fluid 600 psi and Greater	Yellow	Black	HYDRAULIC FLUID-_____PSI

____

TABLE II. COLOR CODE MARKING SIZES

Outside Diameter of Pipe Covering (Inches)	Length of Color Band (inches)	Arrow Length x Width (Inches)	Size of Legend Letters and Numerals (Inches)
Less than 1-1/2	8	8 x 2-1/4	1/2
1-1/2 to 2-3/8	8	8 x 2-1/4	3/4
2-1/2 to 7-7/8	12	8 x 2-1/4	1-1/4
8 to 10	24	12 x 4-1/2	2-1/2
Over 10	32	12 x 4-1/2	3-1/2

3.6   MISCELLANEOUS PAINTING

3.6.1   Lettering

Lettering shall be provided as scheduled on the drawings, shall be [block] [Gothic] type, and shall be [black enamel] [water-type decalcomania, finished with a protective coating of spar varnish]. Samples shall be approved before application.

3.6.2   Obstructions To Aviation

****

NOTE: Structures, such as smokestacks, poles, and buildings, which have been identified as obstruction to aviation will be specified by name. Verify that the structures so identified are not specified to be painted in the sections specifying the structures so that painting will not be specified twice.

****

The following obstructions to aviation shall be painted in the pattern and color prescribed by FAA AC 70/7460-1: [_____]

3.7   SURFACES TO BE PAINTED

Surfaces listed in the painting schedules at the end of this section, other than those listed in paragraph SURFACES NOT TO BE PAINTED, shall be painted as scheduled.

3.8 SURFACES NOT TO BE PAINTED

****

NOTE: List items that might otherwise be covered by the painting schedule. Examples are walls and ceilings in crawl spaces and elevator shafts, unexposed interior ferrous surfaces, and jacketing over insulation pipes in unexposed locations that do not require color coding.

****

Surfaces in the following areas shall not to be painted: [_____]. In addition, surfaces of hardware, fittings, and other factory finished items shall not be painted.

3.9 CLEANING

Cloths, cotton waste and other debris that might constitute a fire hazard shall be placed in closed metal containers and removed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from the site or destroyed in an approved manner. Paint and other deposits on adjacent surfaces shall be removed and the entire job left clean and acceptable.

3.10 PAINTING SCHEDULES

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NOTE: Designer's choices are denoted by solid lines between coating systems. The designer will use the systems most appropriate for local conditions.

Retain Contractor's options, except where specific systems are required to meet project requirements.

Surfaces not required to be painted will be deleted from the painting schedules. Finish coats for specific rooms should be shown in a schedule on the drawings and coordinated with the specifications.

The following guidance is provided to facilitate development of the painting schedule:

Ferrous Metal Primers: Appropriate materials will be selected. SSPC Paint 5 is a two-component primer designed for use on steel cleaned to a commercial blast grade or better and on clean galvanized surfaces. SSPC Paint 25 is designed for use on steel that has been hand-tool cleaned or better. These primers contain no toxic lead or chromate pigments, but this is at a sacrifice of some of the corrosion protection that has been customarily

provided by such pigments.

Painting of Exterior Concrete Masonry Units: Exterior concrete masonry units will be painted when necessary to obtain color compatibility with surrounding areas or to provide waterproofing.

Painting of Exterior Concrete: Exterior concrete surfaces will be painted only when necessary to obtain color compatibility with surrounding areas.

Painting of Concrete Ceilings: Concrete ceilings may be coated with a textured coating or one of the other systems provided for interior concrete surfaces. If the textured coating is selected, the Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE will reflect that a smooth finish is not required under the textured coatings. The textured coating system is suitable for hiding imperfections in new cast-in-place and precast concrete ceilings. The textured coating should not be used in wet or humid areas or for previously painted surfaces.

Painting of Concrete Floors and Walls: Concrete floors will be left unpainted except as required for specific applications. Interior concrete walls will be painted as specified when necessary, except that walls below ground which will be subjected to moisture (e.g., leaking, spills) often enough to damage coatings will not be painted.

Painting of Interior Ferrous Surfaces: Ferrous surfaces in concealed damp spaces, including crawl spaces under buildings, manholes, and tunnels will be painted. The spaces will be designated in the schedule. Concealed ferrous surfaces in dry spaces such as attics, furred spaces between walls and above ceilings, and pipe chases will not be painted. Shop-primed items in concealed spaces will not be finish-painted. Interior ferrous surfaces where ambient conditions can result in the accumulation of moisture, will be painted.

Painting of Exterior Ferrous Surfaces: Exterior ferrous surfaces will receive an exterior oil, aluminum or enamel paint system when exposed to non-corrosive atmospheric conditions. Exterior steel surfaces exposed to salt water or mist, corrosive gases or chemicals should be coated with a coat system compatible with that type environment. CWGS-09940, PAINTING: HYDRAULIC STRUCTURES, contains paint systems suitable for such environments.

Painting of Nonferrous Metallic Surfaces: Nonferrous metallic surfaces will be painted only when the surfaces would present a poor appearance if left bare. When painting is necessary, the size of the surface to be painted will be considered when determining how close a color match is necessary between the final coats over the surface and the adjacent areas. Exterior galvanized, aluminum and other nonferrous surfaces will be painted only when corrosive conditions are extreme or when the surfaces would present a poor appearance if left bare. Copper and lead surfaces, if required to be painted, will receive the same paint system as aluminum surfaces.

Painting of Interior Wood Surfaces: Interior wood surfaces to receive natural finish will be coordinated with other sections of the specifications in reference to the species of wood selected for a particular finish and to verify that the finish is specified in only one section. Knotty wainscots, hardwood wainscots, locker and shower-room benches, and shelves in food-storage rooms will be given a natural finish. Finishing of wood structural glued laminated members, if required, will be specified in the section that covers such members; they will not be field-coated.

Washable Paint Systems: Interior wall surfaces in heavy traffic areas and areas requiring a high degree of sanitation must be painted with a washable paint system. These areas include, hallways, stairwells, lobbies, equipment and supply areas, and facilities such as medical, dental, food preparation, dormitory rooms, and laboratories which need a washable surface for sanitary reasons. These paint systems will not be used as an alternative to glazed structural facing units (GSFU) in kitchen areas of dining facilities. The paint system most suitable for each intended use will be selected and the areas to receive this finish will be identified in the painting schedules.

****

The following painting schedules identify the surfaces to be painted and prescribe the paint to be used and the number of coats of paint to be applied. Contractor options are indicated by ------or------ between optional systems or coats.

EXTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat
Concrete masonry units.	Cement-emulsion filler	FS TT-E-2784 Type III	None
	CID A-A-1500	FS TT-E-2784 Type III	None
	FS TT-E-2784 Type III	FS TT-E-2784 Type III	None

NOTE: Cement-emulsion filler coat shall be acrylic-based and shall consist of the following ingredients in the proportion stated: white portland cement, ASTM C 150, Type I, 16.5 pounds; aggregate 33.5 pounds; mixing liquid, factory-prepared acrylic containing 46 to 47 percent solids, 0.75 gallon; potable water 1.0 gallon maximum; exterior emulsion paint, FS TT-E-2784 Type III 1.0 gallon. Aggregate shall consist of Washed silica sand of the following gradation:

U.S. Sieve Size	Percent Sand (by Weight) Passing Individual Sieve
0.850 mm (20)	100
0.600 mm (30)	95 - 100
0.300 mm (50)	30 - 65
0.150 mm (100)	0 - 10
0.075 mm (200)	0 - 1

Surface	First Coat	Second Coat	Third Coat
Concrete, unless otherwise specified.	FS TT-E-2784 Type III	FS TT-E-2784 Type III	None
Concrete: walls and bottom of swimming pools.	SSPC Paint 18 thin with 1 part of approved thinner to 4 parts of paint by volume	SSPC Paint 18	SSPC Paint 18
Stucco.	FS TT-E-2784 Type III	FS TT-E-2784 Type III	None
	Primer as recommended by FS TT-C-555 manufacturer	FS TT-C-555 Type II	None

EXTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat
Wood, unless otherwise specified.	CID A-A-2336	FS TT-E-2784 Type [_____]	FS TT-E-2784 Type [_____]
	FS TT-E-2784 Type III	FS TT-E-2784 Type [_____]	FS TT-E-2784 Type [_____]
Wood: Steps, platforms, floors, of open porches, [_____].	FS TT-E-2784 Type III	FS TT-E-2784 Type I	FS TT-E-2784 Type I
Wood: stain finish.	FS TT-S-708	None	None
	FS TT-S-001992 Class B	FS TT-S-001992 Class B	None
Hardboard: factory primed.	FS TT-E-2784 Type [_____]	FS TT-E-2784 Type [_____]	None
Ferrous metal unless otherwise specified	SSPC Paint 5	CID A-A-2962 Type I Class [_____] Grade C	CID A-A-2962 Type 1 Class [_____] Grade C
	SSPC Paint 25	CID A-A-2962 Type I Class [_____] Grade C	CID A-A-2962 Type 1 Class [_____] Grade C
	SSPC Paint 23	FS TT-E-2784 Type [I] [II]	FS TT-E-2784 Type [I] [II]
Ferrous metal: subject to high temperature, up to 232 degrees C (450 degrees F), as follows: [_____].	SSPC Paint 20 Type I	None	None
Ferrous metal:	FS TT-P-28	FS TT-P-28	None

EXTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat
subject to high temperature, from 232 degrees C to 649 degrees C (450 degrees F to 1200 degrees F), as follows: [_____].			

NOTE: Commercial blast-cleaning, SSPC SP 6/NACE 3 required. No pretreatment. Maximum total system thickness: 4 mil.

Galvanized metal.	FS TT-E-2784 Type III	FS TT-E-2784 Type [_____]	FS TT-E-2784 Type [_____]
Aluminum aluminum-alloy, and other non-ferrous metal (non-galvanized)	CID A-A-2867	CID A-A-2867	None
	FS TT-E-2784 Type III	FS TT-E-2784 Type [_____]	FS TT-E-2784 Type [_____]

Aviation Obstructions

Masonry & Concrete	FS TT-E-2784 Type III	FS TT-E-2784 Type I	None

Aviation Obstructions

Ferrous Metal	SSPC Paint 25	CID A-A-2962 Type I Class [_____] Grade C	CID A-A-2962 Type I Class [_____] Grade C
	CID A-A-2867	CID A-A-2867	None
	SSPC Paint 23	FS TT-E-2784 Type I	FS TT-E-2784 Type I

INTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat
Plaster, gypsum board, concrete, and concrete masonry units not requiring a smooth finish, unless otherwise specified.	CID A-A-2994 Type II	CID A-A-2246	None
		----------------or----------------	
		CID A-A-2247	None
		----------------or----------------	
		CID A-A-2248	None
Concrete masonry units requiring a smooth finish	CID A-A-1500	CID A-A-2994 Type II	CID A-A-2246 -----or----- CID A-A-2247 -----or----- CID A-A-2248
Concrete: ceilings in following areas: [_____].	Primer as recommended by FS TT-C-555 manufacturer	FS TT-C-555 Type I	None
Concrete: floors requiring dust reduction in following areas [_____].	CID A-A-2542 Type I	None	None
Concrete masonry units in food-preparation, food-serving, restrooms and laundry areas, unless otherwise specified	CID A-A-1500	CID A-A-2994 Type II	FS TT-E-2784
Plaster and gypsum board: in food-preparation, food-serving, restrooms and laundry areas,	CID A-A-2994 Type II	FS TT-E-2784 Type [_____]	None

unless otherwise specified.			
Concrete masonry units: in, shower areas, and areas requiring a high degree of sanitation, unless otherwise specified.	CID A-A-1500	CID A-A-2994 Type II	FS TT-E-2784 Type [_____]
Plaster and gypsum board: in shower areas, and areas requiring a high degree of sanitation, unless otherwise specified.	CID A-A-2994 Type II	FS TT-E-2784 Type [_____]	None
Concrete masonry units, plaster, and gypsum board: for walls in heavy traffic areas in space as follows:	CID A-A-1500	CID A-A-2994 Type II	CID A-A-2246 -----or------ CID A-A-2247
Hardboard.	CID A-A-2994 Type I	CID A-A-2246	CID A-A-2246
		----------------or----------------	
		CID A-A-2247	CID A-A-2247
		----------------or----------------	
		CID A-A-2248	CID A-A-2248
Ferrous Metal unless otherwise specified	SSPC Paint 25	CID A-A-2962 Type I Class [_____] Grade C	CID A-A-2962 Type I Class [_____] Grade C
	SSPC Paint 23	FS TT-E-2784 Type [I] [II]	FS TT-E-2784 Type [I] [II]
	CID A-A-2867	CID A-A-2867	None

Aluminum and aluminum alloy unless otherwise specified.	CID A-A-2867	CID A-A-2867	None
	FS TT-E-2784 Type III	FS TT-E-2784 Type [I] [II]	FS TT-E-2784 Type [I] [II]
Ferrous metal in concealed damp spaces or in exposed areas having unpainted adjacent surfaces as follows: [_____]	CID A-A-1632	None	None
Ferrous metal factory-primed mechanical and electrical equipment.	Two coats of paint as recommended by the equipment manufacturer		None
Galvanized metal:	FS TT-E-2784 Type III	FS TT-E-2784 Type [_____]	None
	SSPC Paint 5	CID A-A-2962 Type I Class [_____] Grade C	CID A-A-2962 Type I Class [_____] Grade C
	SSPC Paint 25	CID A-A-2962 Type I Class [_____] Grade C	CID A-A-2962 Type I Class [_____] Grade C
	SSPC Paint 23	FS TT-E-2784 Type [_____]	FS TT-E-2784 Type [_____]
Wood: unless otherwise specified.	CID A-A-2994 Type I	CID A-A-2246	None
		-----------------or---------------	
		CID A-A-2247	None
		-----------------or---------------	
		CID A-A-2248	None
Wood: stain and varnish finishes as follows: [_____]	Commercially available stain	CID A-A-1788 Type [_____] Class I	CID A-A-1788 Type [_____] Class I

		In addition a fourth coat of CID A-A-1788 Type [_____] Class I	
	CID A-A-2339	CID A-A-2834 Type I Class [_____] In addition a fourth coat of CID A-A-2834 Type I Class [_____]	CID A-A-2834 Type I Class [_____]
Wood: floors to receive paint finish.	CID A-A-2994 Type I	FS TT-E-2784 Type [_____] Type I or II	FS TT-E-2784 Type [_____] Type I or II
Wood: floors, except gymnasium floors, to receive stain or natural finish in spaces as follows. [_____]	FS TT-C-542 Type I, Class A	FS TT-C-542 Type I, Class A	None
Wood: gymnasium floors.	CID A-A-2335	CID A-A-2335	Oleoresinous-type gymnasium floor finish. per MFMA-03
	FS TT-C-542 Type I, Class A	FS TT-C-542 Type I, Class A	None
Wood: handrails.	CID A-A-1788 Type [_____] Class [_____]	CID A-A-1788 Type [_____] Class [_____]	CID A-A-1788
	CID A-A-1546	CID A-A-1546	CID A-A-1546
Wood: natural finish as follows: [_____]	CID A-A-1546	CID A-A-1546	CID A-A-1546
Ferrous Metal: Convector	SSPC Paint 23	None	None

enclosures, electrical conduit runs: metallic tubing uninsulated ducts and pipes, pipe hangers, louvers, grilles, and air outlets, in areas having painted adjacent surfaces.			
Aluminum and Galvanized Surface Metal: Convector enclosures, electrical conduit runs metallic tubing uninsulated ducts and pipes, pipe hangers, louvers, grilles, and air outlets, in areas having painted adjacent surfaces.	FS TT-E-2784	CID A-A-2246 ----------------or CID A-A-2247 ----------------or CID A-A-2248	CID A-A-2246 -------------- CID A-A-2247 -------------- CID A-A-2248
Metal: surfaces subject to high temperature, up to 232 degrees C (450 degrees F), as follows: [_____].	SSPC Paint 20 Type I	None	None
Metal: surfaces subject to temperature from 232 degrees C to 649 degrees C (450 degrees F to 1200 degrees F), as follows: [_____].	FS TT-P-28	FS TT-P-28	None

NOTE: Commercial blast-cleaning, SSPC SP 6/NACE 3 or better required. No pretreatment. Maximum total dry film thickness: 4 mil.

Facing of vapor barrier jackets of presized or adhesive	Two coats of paint to match adjacent areas		None

finished cloth
cover insulation
on pipes, ducts,
and equipment in
following area.
[_____]

-- End of Section --

****

DEPARTMENT OF THE ARMY **CEGS-09915 (June 1993)**
U.S. ARMY CORPS OF ENGINEERS ________________________

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 2 (May 1995)
Includes note relocation Special change (August 1995)
Includes Text Adjustment Change 2 (Reference Paragraph)(September 1997)

Latest Notice change indicated by CHG tags

****

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SECTION 09915

COLOR SCHEDULE

06/93

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PART 3 EXECUTION (Not Applicable)

-- End of Section Table of Contents --

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DEPARTMENT OF THE ARMY **CEGS-09915 (June 1993)**
U.S. ARMY CORPS OF ENGINEERS

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 2 (May 1995)
Includes note relocation Special change (August 1995)
Includes Text Adjustment Change 2 (Reference Paragraph)(September 1997)

Latest Notice change indicated by CHG tags
****

SECTION 09915

COLOR SCHEDULE
06/93

****
NOTE: This guide specification covers the requirements for color of exterior and interior materials and products. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 GENERAL

This section covers only the color of the exterior and interior materials and products that are exposed to view in the finished construction. The word "color" as used herein includes surface color and pattern. Requirements for quality and method of installation are covered in other appropriate sections of the specifications. Specific locations where the various materials are required are shown on the drawings. Items not designated for color in this section may be specified in other sections. When color is not designated for items, the Contractor shall propose a color for approval.

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

Construction color boards are required for some Air Force facilities. Delete the color board requirements when not applicable. Item e - Add other addresses required to receive color boards. The submittal should be designated "FIO" since material sample approval is given in quality specifications.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-14 Samples

Color board; [_____].

[_____] sets of color boards, [_____] [120] days after the Contractor is given Notice to proceed, complying with the following requirements:

a. Color boards shall reflect all actual finish textures, patterns, and colors required for this contract.
b. Materials shall be labeled with the finish type, manufacturer's name, pattern, and color reference.

c. Samples shall be on size A4 or 8-1/2 by 11 inch boards with a maximum spread of size A1 or 25-1/2 by 33 inches for foldouts.

d. Samples for this color board are required in addition to samples requested in other specification sections.

e. Color boards shall be submitted to the following addresses: [_____].

PART 2 PRODUCTS

2.1 REFERENCE TO MANUFACTURER'S COLOR

****

NOTE: Where manufacturer's items are referenced for color, check to ensure that the referenced item complies with the appropriate quality standards specified in other Sections.

****

Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers.

2.2 COLOR SCHEDULE

****

NOTE: The materials and items contained in this specification are not intended to limit selections of materials to a specific product. Additional materials may be added to the specification. Items not pertaining to the project will be deleted by the designer. Include applicable mechanical and electrical items that have an impact on the aesthetics of a facility. These may include the following exterior items: diesel generator sets, transformers, exhaust fans, and condensing units. Interior considerations may include computer room air conditioners (CRAC units), exhaust grilles, fan coil units, fin tube/convectors, and sprinkler heads. Eliminate trim items not requiring painting (example: stainless access panels). Add exterior paving materials such as pavers and integrally colored CMU when utilized.

When this specification is utilized, reference will be made in applicable guide specifications clarifying that "color will be as specified in Section 09915 COLOR SCHEDULE."

Color references indicated after finishes shown in paragraph COLOR SCHEDULE should include the manufacturer, pattern name (when applicable), and color name of the finish (example: Vinyl Composition Tile: XYZ Co., Pattern Stonegate, Color Tourmaline). The Color Schedule may contain a reference to another specification section where the color is designated. (example: Signage: See Section 10440 INTERIOR SIGNAGE for color).

When the project is large or the design is complicated, the pattern and color of exterior and interior finishes may be specified on the Room Finish Schedule drawing. The designer should add notes to the drawing to specify color for all applicable items specified in paragraphs Exterior Walls through Interior Miscellaneous. Another option for larger facilities is to utilize this section together with the Room Finish Schedule Drawing. In this instance, the designer can use the drawing to indicate placement, using abbreviations such as C-1 and C-2 (Carpet-1, Carpet-2). The designer must include a statement on the drawing

clarifying that "color designations shall be as indicated in Section 09915 COLOR SCHEDULE." Section 09915 is then utilized to specify a manufacturer's reference for all exterior and interior finishes in the following manner: Carpet C-1: XYZ Co., pattern Pebbleweave, color DF506-204 Vienna Woods. The designer should then include a statement that the placement of flooring, base, wall, and ceiling finishes shall be shown on the Room Finish Schedule on the drawings. This method is desirable since it keeps all manufacturer's color references in one location. Regardless of which method the designer utilizes, the design needs to be complete and redundancy eliminated from design documents.

This section does not cover the quality of finish materials.
****

The color schedule lists the colors, patterns and textures required for exterior and interior finishes, including both factory applied and field applied colors.

2.2.1 Exterior Walls

Exterior wall colors shall apply to exterior wall surfaces including recesses at entrances and projecting vestibules. Conduit shall be painted to closely match the adjacent surface color. Wall color shall be provided to match the colors listed below.

a. Brick: [_____].

b. Mortar: [_____].

c. Paint: [_____].

d. Concrete Masonry Units (Integrally Colored): [_____].

e. Metal Wall Panels, Hardware, and Associated Trim: [_____].

f. Insulation and Finish System: [_____].

g. Precast Concrete: [_____].

h. Glass and Glazing: [_____].

2.2.2 Exterior Trim

Exterior trim shall be provided to match the colors listed below.

a. Doors and Door Frames: [_____].

b. Windows (mullion, muntin, sash, trim, and sill): [_____].

c. Wood Stain: [_____].

d. Fascia: [_____].

e. Downspouts, Gutter, Louvers, and Flashings: [_____].

f. Handrails: [_____].

g. Soffits and Ceilings: [_____]

h. Signage: [_____].

i. Overhangs: [_____].

j. Caulking and Sealants: [_____].

2.2.3 Exterior Roof

Roof color shall apply to exterior roof surfaces including sheet metal flashings and copings, mechanical units, roof trim, pipes, conduits, electrical appurtenances, and similar items. Roof color shall be provided to match the colors listed below.

a. Metal: [_____].

b. Shingles: [_____].

c. EPDM: [_____].

2.2.4 Interior Floor Finishes

Flooring materials shall be provided to match the colors listed below.

a. Carpet: [_____].

b. Carpet Tile: [_____].

c. Vinyl Composition Tile: [_____].

d. Sheet Vinyl: [_____].

e. Raised Pattern Rubber Tile: [_____].

f. Stair Treads, Kick Strips, and Risers: [_____].

g. Quarry Tile: [_____].

h. Ceramic Tile: [_____].

i. Porcelain Tile: [_____].

j. Grout: [_____].

k. Plastic Laminate: [_____].

l. Wood: [_____].

m. Static [Dissipative] [Conductive] Tile: [_____].

n. Concrete: [_____].

2.2.5 Interior Base Finishes

Base materials shall be provided to match the colors listed below.

a. Resilient Base and Edge Strips: [_____].

b. Quarry Tile: [_____].

c. Ceramic Tile: [_____].

d. Porcelain Tile: [_____].

e. Grout: [_____].

f. Coved Sheet Vinyl: [_____].

g. Glazed Structural Units: [_____].

h. Prefaced Concrete Masonry Units: [_____].

i. Brick: [_____].

j. Mortar: [_____].

k. Painted: [_____].

l. Wood: [_____].

2.2.6 Interior Wall Finishes

Interior wall color shall apply to the entire wall surface, including reveals, vertical furred spaces, grilles, diffusers, electrical and access panels, and piping and conduit adjacent to wall surfaces unless otherwise specified. Items not specified in other paragraphs shall be painted to match adjacent wall surface. Wall materials shall be provided to match the colors listed below.

a. Paint: [_____].

b. Vinyl Wall Covering: [_____].

c. Fabric Wall Covering: [_____].

d. Ceramic Tile: [_____].

e. Ceramic Tile Grout: [_____].

f. Acoustical Wall Covering: [_____].

g. Brick: [_____].

h. Metal Liner Panels: [_____].

i. Glazed Structural Units: [_____].

j. Prefaced Concrete Masonry Units: [_____].

k. Mortar: [_____].

l. Columns: [_____].

2.2.7 Interior Ceiling Finishes

Ceiling colors shall apply to ceiling surfaces including soffits, furred down areas, grilles, diffusers, registers, and access panels. Ceiling color shall also apply to joist, underside of roof deck, and conduit and piping where joists and deck are exposed and required to be painted. Ceiling materials shall be provided to match the colors listed below.

a. Acoustical Tile and Grid: [_____].

b. Paint: [_____].

c. Structural Framing: [_____].

d. Metal Deck: [_____].

2.2.8 Interior Trim

Interior trim shall be provided to match the colors listed below.

a. Doors: [_____].

b. Door Frames: [_____].

c. Windows (mullion, muntin, sash, trim, and stool): [_____].

d. Window Sills: [_____].

e. Fire Extinguisher Cabinets: [_____].

f. Handrails: [_____].

g. Ladders: [_____].

h. Metal Stairs: [_____].

i. Wood Stain: [_____].

2.2.9 Interior Window Treatment

Window treatments shall be provided to match the colors listed below.

a. Horizontal Blinds: [_____].

b. Vertical Blinds: [_____].

c. Integral Blinds: [_____].

d. Drapery Hardware: [_____].

2.2.10 Interior Miscellaneous

Miscellaneous items shall be provided to match the colors listed below.

a. Toilet Partitions and Urinal Screen: [_____].

b. Plastic Laminate: [_____].

c. Signage Message Color (excluding handicapped signage): [_____].

d. Signage Background Color (excluding handicapped signage): [_____].

e. Lockers: [_____].

f. Operable Partitions: [_____].

g. Corner Guards: [_____].

h. Wall Switch Handles and Standard Receptacle Bodies: [_____].

i. Electrical Device Cover Plates and Panels: [_____].

j. Casework: [_____].

k. Shower Curtain: [_____].

PART 3 EXECUTION (Not Applicable)

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-10160 (July 1998)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**
Superseding
CEGS-10160 (August 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

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07/98

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-- End of Section Table of Contents --

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DEPARTMENT OF THE ARMY | **CEGS-10160 (July 1998)**
U.S. ARMY CORPS OF ENGINEERS | **------------------------**
Superseding
CEGS-10160 (August 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 10160

TOILET PARTITIONS
07/98

****
NOTE: This guide specification covers the requirements for toilet enclosures, room entrance screens, and urinal screens. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: Buildings not excluded by AEI Design Criteria will be accessible in accordance with 36 CFR 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities.

Drawings will indicate location, dimensions, schedules, elevations, details, and such other information as required to indicate the extent of the work.
****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-60003	Partitions, Toilet, Complete

1.2 SYSTEM DESCRIPTION

Toilet partition system, including toilet enclosures, room entrance screens, and urinal screens, shall be a complete and usable system of panels, hardware, and support components. The partition system shall be provided by a single manufacturer and shall be a standard product as shown in the most recent catalog data. The partition system shall be as shown.

1.3 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Toilet Partition System; [_____].

Manufacturer's technical data and catalog cuts including installation and cleaning instructions.

SD-04 Drawings

Toilet Partition System; [_____].

Drawings showing plans, elevations, details of construction, hardware, reinforcing, fittings, mountings, and anchorings.

SD-14 Samples

Toilet Partition System; [_____].

Manufacturer's standard color charts and color samples.

1.4 DELIVERY, STORAGE, AND HANDLING

Components shall be delivered to the jobsite in the manufacturer's original packaging with the brand, item identification, and project reference clearly marked. Components shall be stored in a dry location that is adequately ventilated; free from dust, water, or other contaminants; and shall have easy access for inspection and handling.

1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2 PRODUCTS

****

NOTE: Painted metal (Finish 1) toilet enclosures, urinal screens, and room entrance screens are suitable for use in installations where the partitions are subjected to normal usage and exposure conditions. Laminated plastic (Finish 3) toilet partitions will not be used where severe water conditions will be encountered, such as where cleaning is to be performed by spraying water.

Where toilet partitions are indicated for hard usage or severe exposure areas, finishes other than painted metal (Finish 1) or laminated plastic (Finish 3) should be specified when their high initial cost can be justified through life cycle cost. The least expensive painted metal finish is generally the least durable of the finishes listed in CID A-A-60003. Laminated plastic (Finish 3) costs more than the painted metal and less than stainless steel (Finish 2), solid phenolic (Finish 4), or solid polyethylene (Finish 5). Laminated plastic (Finish 3) finishes are hard and smooth; resistant to wear, scratches, periodic moisture, impact, acids and alkalies, and cigarette burns. Next to stainless steel (Finish 2), the solid plastics (phenolic and polyethylene) are the most durable finishes available. When finishes other than painted metal (Finish 1) are being considered, laminated plastic (Finish 3) should be the next logical choice, followed by solid plastics and stainless steel (Finish 2), and solid phenolic (Finish 4). Polyethylene (Finish 5), stainless steel (Finish 2), and solid phenolic (Finish 4) are highly resistant to humidity, steam, detergents, cleaning chemicals and corrosion. Interior fire and smoke finish classification must be addressed when materials other than metal partitions are being

considered. Edit the following paragraphs for styles and finishes.

Generally, floor-supported enclosures, Style A, will be used; and overhead braced enclosures, Style C, and overhead braced-alcove, Style F, will be used when pilasters cannot be anchored into minimum 76 mm (3 inches) thick structural concrete. Ceiling hung enclosures, Style B, will be used only when the additional cost is justified for reasons of sanitation or appearance. Ceiling hung enclosures, Style B, are not recommended by manufacturers when ceiling height is greater than 2590 mm (8 feet 6 inches). Urinal screens, when deemed necessary, may be any of the 6 styles available, but the floor to ceiling hung screen, Style D, is the most justifiable for reasons of cost and sanitation. Type II, Style D, room entrance screens are generally the most durable style due to the floor to ceiling post support design. Edit as needed to meet project requirements.

****

2.1 TOILET ENCLOSURES

Toilet enclosures shall conform to CID A-A-60003, Type I, Style [A, floor supported] [B, ceiling hung] [C, overhead braced] [F, overhead braced-alcove]. Width, length, and height of toilet enclosures shall be as shown. Finish surface of panels shall be [painted metal, Finish 1] [laminated plastic, Finish 3] [_____]. Panels indicated to receive toilet paper holders or grab bars as specified in Section 10800 TOILET ACCESSORIES, shall be prepared for mounting of the items required. Grab bars shall withstand a bending stress, shear stress, shear force, and a tensile force induced by 250 lbf. Grab bars shall not rotate within their fittings.

2.2 ROOM ENTRANCE SCREENS

****

NOTE: Length and height of room entrance screens will be shown on the drawings, using standard size panels and pilasters to the maximum extent practicable.

****

Room entrance screens shall conform to CID A-A-60003, Type II, Style [A, floor supported] [E, wall hung] [_____]. Finish surface of screens shall be [painted metal, Finish 1] [laminated plastic, Finish 3] [_____]. Length and height of screens shall be as shown.

2.3 URINAL SCREENS

****

NOTE: Use of urinal screens between individual urinals will be dependant on the function of the facility. Use of urinal screens will normally be

limited to those applications where sanitary protection is required, such as between a urinal and an immediately adjacent lavatory. Style A screens should normally be between 600 to 900 mm (24 to 36 in) wide. Style E screens should normally be between 400 to 600 mm (18 to 24 in) wide. Wall hung, Style E, urinal screens will be used only where the supporting construction is masonry or concrete.

****

Urinal screens shall conform to CID A-A-60003, Type III, Style [A, floor supported] [D, floor to ceiling hung]. Finish surface of screens shall be [painted metal, Finish 1] [laminated plastic, Finish 3] [_____]. Width and height of urinal screens shall be as shown.

2.4 HARDWARE

Hardware for the toilet partition system shall conform to CID A-A-60003 for the specified type and style of partitions. Hardware finish shall be highly resistant to alkalies, urine, and other common toilet room acids.

2.5 COLORS

Color of finishes for toilet partition system components shall be manufacturer's standard [as specified in Section 09915 COLOR SCHEDULE] [_____].

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: Toilet partitions in barracks, and other hard usage areas, as well as those partitions on which grab bars are to be mounted, will be bolted to walls. Through-bolting will be specified for these applications; except, toggle bolts may be specified when through-bolting would be exposed in a finished room or would otherwise be unsuitable.

****

Toilet partitions shall be installed straight and plumb in accordance with approved manufacturer's instructions with horizontal lines level and rigidly anchored to the supporting construction. Where indicated, anchorage to walls shall be by [through-bolting] [toggle-bolting]. Drilling and cutting for installation of anchors shall be at locations that will be concealed in the finished work.

3.2 ADJUSTING AND CLEANING

Doors shall have a uniform vertical edge clearance of approximately 3/16 inch and shall rest open at approximately 30 degrees when unlatched. Baked enamel finish shall be touched up with the same color of paint that was used for the finish. Toilet partitions shall be cleaned in accordance with approved manufacturer's instructions and shall be protected from damage until accepted.

-- End of Section --

****

DEPARTMENT OF THE ARMY | **CEGS-10260 (December 1995)**
U.S. ARMY CORPS OF ENGINEERS | **-------------------------**
Superseding
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GUIDE SPECIFICATION FOR CONSTRUCTION

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Includes Text Adjustment Change (Section 01300 Reference) (June 1997)

****

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12/95

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-- End of Section Table of Contents --

****

DEPARTMENT OF THE ARMY **CEGS-10260 (December 1995)**
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****

SECTION 10260

WALL AND CORNER PROTECTION
12/95

****
NOTE: This guide specification covers the requirements for corner guards, wall guards (bumper guards), door protectors, and wall panels. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: Facilities not excluded by AEI Design Criteria will be accessible in accordance with 36 CFR, Part 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities. Handrails, wall guards (bumper guards), corner guards, wall panels, and door protector locations, general configuration, mounting details, and dimensions will be shown on the drawings. Drawings should show basic profiles and details but should not be so explicit that they become proprietary in nature.

****

1.1 REFERENCES

specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the

designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF-45	(1980; R 1993) Designation System for Aluminum Finishes
ASTM A 167	(1996) Stainless and Heat-Resisting
	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
	(1993a) Determining the Pendulum Impact Resistance of Notched Specimens of Plastics
ASTM D 635	(1996) Rate of Burning and/or Extent and Plastics in a Horizontal Position
ASTM E 84	(1996a) Surface Burning Characteristics of

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

	(1988) Metal Finishes Manual for Architectural and Metal Products

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80

SOCIETY OF AMERICAN AUTOMOTIVE ENGINEERS (SAE)

SAE J1545	(1986) Instrumental Color Difference Textiles and Color Trim

1.2 SUBMITTALS

****
adequate quality control. The importance of an item in the

project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Corner Guards; [_____]. Wall Guards (Bumper Guards); [_____]. Door Protectors; [_____]. Wall Covering/Panels; [_____].

Manufacturer's descriptive data, catalog cuts, installation instructions, and recommended cleaning instructions.

SD-04 Drawings

Corner Guards; [_____]. Wall Guards (Bumper Guards); [_____]. Door Protectors; [_____]. Wall Covering/Panels; [_____].

Drawings indicating locations and typical elevations of each type of item. Drawings shall show vertical and horizontal dimensions, full size sections, thickness

SD-13 Certificates

Corner Guards; [_____]. Wall Guards (Bumper Guards); [_____]. Door Protectors; [___

Statements attesting that the items comply with specified fire and safety code requir

SD-14 Samples

Finish; [_____].

Manufacturer's standard samples indicating color and texture of materials requiring c

1.3 DELIVERY AND STORAGE

damage, and stored under cover. Materials shall be stored at approximately 70 degree

1.4 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2 PRODUCTS

2.1 GENERAL

****
NOTE: All paragraphs must be carefully edited because of the broad number of possible requirements and the diverse combinations available with these products.
****

To the maximum extent possible, corner guards, door and door frame protectors, wall guards (bumper guards), wall panels and wall covering shall be the standard products of a single manufacturer and shall be furnished as detailed. Drawings show general configuration of products required, and items differing in minor details from those shown will be acceptable.

2.1.1 Resilient Material

the following:

2.1.1.1 Minimum Impact Resistance

accordance with ASTM D 256, (Izod impact, ft. lbs per sq inch notched).

2.1.1.2 Fire Rating

Fire rating shall be Class 1 when tested in accordance with ASTM E 84,

less. Material shall be rated self extinguishing when tested in accordance with

known testing laboratory. Resilient material used for protection on fire rated doors

any other combination of door/frame assembly will not be acceptable.

2.1.1.3 Integral Color

Colored components shall have integral color and shall be matched in accordance with SAE J1545 to within plus or minus 1.0 on the CIE-LCH scales.

2.2 CORNER GUARDS

****
NOTE: For medical facilities, corner guards must extend from floor to ceiling.
****

2.2.1 Resilient Corner Guards

Corner guard units shall be [flush mounted] [surface mounted] type, radius formed to profile shown. Corner guards [shall extend from floor to ceiling.] [shall be [_____] feet high.] Mounting hardware, cushions, and base plates shall be furnished. Assembly shall consist of a snap-on corner guard formed from high impact resistant resilient material, minimum 0.078 inch thick, mounted on a continuous aluminum retainer. Extruded aluminum retainer shall conform to ASTM B 221, alloy 6063, temper T5 or T6. Flush mounted type guards shall act as a stop for adjacent wall finish material. Factory fabricated end closure caps shall be furnished for top and bottom of surface mounted corner guards. Flush mounted corner guards installed in fire rated wall shall maintain the rating of the wall. Insulating materials that are an integral part of the corner guard system shall be provided by the manufacturer of the corner guard system. Exposed metal portions of fire rated assemblies shall have a paintable surface.

2.2.2 Stainless Steel Corner Guards

Stainless steel corner guards shall be fabricated of 0.0625 inch thick

ceiling.] [shall be [_____] feet high.] Corner guard shall be formed to dimensions shown.

2.3 WALL GUARDS (BUMPER GUARDS)

2.3.1 Wall Guards, Combination Handrail/Wall Guards and Handrails

Wall guards, combination handrail/wall guards, and handrails shall be provided with prefabricated end closure caps, inside and outside corners, concealed splices, cushions, mounting hardware and other accessories standard with the manufacturer. Extruded aluminum retainers shall conform to ASTM B 221, alloy 6063, temper T5 or T6. End caps and corners shall be field adjustable to assure close alignment with handrails and wall guards.

shown] [as shown with [vinyl] [carpet] [_____] inserts].

Wall guards shall consist of snap-on covers of high impact resistant resilient material, minimum 0.078 inch thick, mounted over [2] [_____] inch wide aluminum, minimum 0.062 inch thick retainer, anchored to wall at maximum 24 inches on center.

2.3.1.2 Combination Handrail/Wall Guards

Combination handrail/wall guards shall consist of snap-on covers of high impact resistant resilient material, minimum 0.078 inch thick, on a continuous, extruded aluminum retainer, minimum 0.072 inch thick anchored to wall at maximum 32 incheson center.

2.3.1.3 Handrails

Handrails shall consist of snap-on covers of high impact resistant resilient material, minimum 0.078 inch thick on a continuous extruded aluminum retainer, minimum 0.072 inch thick anchored to wall at maximum 32 inches on center. Handrails shall be provided with prefabricated end closure caps, inside and outside corners, concealed splices, cushions, mounting hardware and other accessories standard with the manufacturer. End caps and corners shall be field adjustable to assure close alignment with handrails.

2.4 DOOR PROTECTORS

[Door] [door envelope] [door knob] [and] [door frame] protection items shall consist of high impact resistant acrylic vinyl or polyvinyl chloride resilient material, minimum [0.060 inch thick for doors] [and] [0.035 inch thick for door frames].

2.5 WALL COVERING/PANELS

****

NOTE: Recommended locations for various thicknesses of rigid wall covering/panels are as follows: 0.50 mm (0.022 inch) to 1.02 mm (0.040 inch) thick for lobbies and elevator areas, 1.52 mm (0.060 inch) to 2.03 mm (0.080 inch) thick for service corridors, and 2.38 mm (0.093 inch) to 3.1 mm (0.125 inch) thick for loading dock areas. A 9.53 mm (0.375

inch) thick composite wall panel is recommended for

ceramic tile, masonry block, or damaged plaster/drywall.
****

polyvinyl chloride resilient material. Panel sizes shall be [2 x 4 ft.] [_____].

inch].

2.5.2 High Impact Wall Panels

Panel face shall be factory banded to a 0.375 inch thick fiberboard core. The backside of the panel shall be laminated with a moisture resistant vapor barrier.

2.6 TRIM, FASTENERS AND ANCHORS

Vinyl trim, fasteners and anchors shall be provided for each specific installation as shown.

Finish for aluminum shall be in accordance with AA DAF-45. Exposed aluminum

with integrally colored anodic coating] class II architectural coating 0.4 mil thick. Concealed aluminum shall be mill finish.

2.7.2 Stainless Steel Finish

Finish for stainless steel shall be in accordance with NAAMM AMP 500 Manual, finish number 4.

2.7.3 Resilient Material Finish

****
NOTE: Coordinate resilient finishes with manufacturers. Certain finishes and textures are not available from some manufacturers.
****

Finish for resilient material shall be [embossed [velour] [stipple] [_____]] [[fake woodgrain] [high gloss vinyl]] texture with colors in accordance with SAE J1545.

2.8 ADHESIVES

Adhesive for resilient material shall be in accordance with manufacturers recommendations.

2.9 COLOR

Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

3.1 INSTALLATION

recommendations.

be installed in accordance with NFPA 80.

-- End of Section --

****
DEPARTMENT OF THE ARMY **CEGS-10270 (January 1997)**
U.S. ARMY CORPS OF ENGINEERS **-------------------------**
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Latest change indicated by CHG tags
****

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****

SECTION 10270

RAISED FLOOR SYSTEM
01/97

****

NOTE: This guide specification covers the requirements for a raised floor system. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

****

NOTE: Raised floor systems include floor panels, pedestals and items such as stringers, steps, ramps, closures and trim. Raised floor systems must be designed to accommodate static, rolling and impact loading.

The designer is responsible for identifying and defining requirements for the floors. Drawings will indicate location and limits of raised floor systems, finish floor elevation, stair and/or ramp

information such as tread width and riser height for stairs and width slope and length of ramps, connection to ground, and any other information required to indicate the extent of work.

Seismic loadings must be considered in designing raised floor systems. Design Analysis and Calculations will specify seismic design calculations under SD-01 in paragraph SUBMITTALS.

There are three types of flooring installations:

Type I Raised floors completely surrounded by building walls. These are the most resistant to seismic loadings.

Type II Raised floors with part of the edge exposed and not restrained by other structural elements. Type II floors are less resistive to seismic loadings along the axis of the unconstrained side. Seismic loadings can be resisted by securing the perimeter panels of all floors to the supporting structural framing and fitting the panels tightly together, or by cross bracing the structural frame to resist overturning.

Type III Raised floors are free standing without lateral contact with other structural elements. Type III floors are primarily strengthened with cross bracing to resist loads defined by the UBC.

Buildings not excluded by AEI Design Criteria will be accessible in accordance with 36 CFR, Part 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A208.1 (1993) Particleboard

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84	(1998el) Surface Burning Characteristics of Building Materials
ASTM E 648	(1997) Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

CEILINGS AND INTERIOR SYSTEMS CONTRACTORS ASSOCIATION (CISCA)

CISCA Access Floors	(1987) Recommended Test Procedures for Access Floors

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1	(1996) Voluntary Product Standard - Construction and Industrial Plywood

FEDERAL SPECIFICATIONS (FS)

FS SS-T-312	(Rev B; Int Am 1; Notice 2) Tile, Floor: Asphalt, Rubber, Vinyl, and Vinyl Composition

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO Bldg Code	(1997) Uniform Building Code (3 Vol.)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3	(1995) High-Pressure Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 75	(1999) Protection of Electronic Computer/Data Processing Equipment
NFPA 99	(1999) Health Care Facilities

UNDERWRITERS LABORATORIES (UL)

UL 779	(1995; Rev thru Jan 1997) Electrically Conductive Floorings

1.2 SYSTEM DESCRIPTION

****

NOTE: Raised flooring support systems are available as either a stringer or stringerless system. A stringer is a horizontal framing member that connects the pedestal head, supports the panel edges and adds lateral stability to the floor system.

Stringers should be used on all systems with a height that exceeds 300 mm (12 inches).

For Army facilities, specify the stringer system when the total area is over 371 square meters (4000

square feet) unless the system provides bolted connection between the panel and pedestal.

For Army facilities requiring stringer type systems, aluminum, holder formed steel, metal-clad cementitious fill, metal-clad wood core and concrete panels may be used.

For Air Force facilities, use stringer Type floor systems for data processing facilities.

For Air Force facilities requiring stringer type floor systems, aluminum, hollow formed steel and metal-clad wood core are permitted options.
****

Raised flooring shall be installed at the location and elevation and in the arrangement shown on the drawings. The floor system shall be of the [stringer] [or] [stringerless] type, complete with all supplemental items, and shall be the standard product of a manufacturer specializing in the manufacture of raised floor systems.

1.2.1 Floor Panels

****
NOTE: Insert heavier load as required by facility use conditions. The deflection and permanent deformation limits are for panels 610 mm by 610 mm, (24 by 24 inches) and smaller.
****

Floor panel testing shall be conducted in accordance with CISCA Access Floors. When tested as specified, all deflection and deformation measurements shall be made at the point of load application on the top surface of the panel. Floor panels shall be capable of supporting [1000] [1250] [1500] [_____] pounds concentrated load without deflecting more than 0.080 inch and without permanent deformation in excess of 0.010 inch in any of the specified tests. Floor panels shall be capable of supporting [250] [300] [350] [_____] pounds per square foot uniform live load without deflection more than 0.040 inch. Floor panels shall be capable of supporting [600] [1000] [_____] pounds rolling load without deflecting more than 0.040 inch and without permanent deformation in excess of 0.020 inch. In accordance with CISCA Access Floors, the permanent deformation limit under rolling load shall be satisfied in all of the specified tests. In the specified tests, the permanent deformation shall be measured after 10 passes with Wheel 1 and after 10,000 passes with Wheel 2.

1.2.2 Stringers

Stringers shall be capable of supporting a 250 poundconcentrated load at midspan without permanent deformation in excess of 0.010 inch.

1.2.3 Pedestals

****
NOTE: Pedestals consist of a base plate, post and an adjustable head, and are available in heights

from 150 mm (6 inches) to 2400 mm (96 inches). Pedestals 24 inches high or higher will be securely anchored to the structural floor in addition to being held in place by adhesive.

Pedestals are normally held in place with an adhesive and must be in full contact with the subfloor surface. Pedestal 600 mm (24 inches) high or higher will be securely anchored to the structural floor in addition to the adhesive.

For Air Force projects, the minimum pedestal height is 300 mm (12 inches).

****

Pedestals shall be capable of supporting a 5000 poundaxial load without permanent deformation.

1.2.4 Pedestal Adhesive

Adhesive shall be capable of securing a pedestal in place with sufficient bonding strength to resist an overturning force of 1000 inch pounds.

1.2.5 Bond Strength of Factory Installed Floor Covering

Bond strength of floor covering shall be sufficient to permit handling of the panels by use of the panel lifting device, and to withstand moving caster loads up to 1000 pounds, without separation of the covering from the panel.

1.2.6 Leakage

****

NOTE: Requirements for air leakage will be deleted when the space under the finished floor will not be used as an air plenum. Concrete floors to be used as air plenums shall be painted in accordance with Section 09900 PAINTING, GENERAL.

****

When the space below the finished floor is to be an air plenum, air leakage through the joints between panels and around the perimeter of the floor system shall not exceed 0.1 cubic foot of air per minute per linear foot of joint subjected to 0.1 inch, water gauge, positive pressure in the plenum.

1.2.7 Grounding

****

NOTE: Grounding will be specified when the raised floor is to be used for electronic equipment, automatic data processing equipment, or other complex electrical equipment. The specified limits for the resistance values from panels to ground are standard within the industry. These limits may be changed if other values are required by the Using Agency. The grounded floor system should be

designed to provide positive contact between all metal components. Grounding details must be shown on the project drawings; the option of using manufacturer's alternate methods of grounding may be included in the project specification.
****

The raised floor system shall be grounded for safety hazard and static suppression.

1.3 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Raised Floor System; [_____].

Manufacturer's descriptive data, catalog cuts, and installation instructions. The data shall include information about any design and production techniques, procedures and policies used to conserve energy, reduce material, improve waste management or incorporate green building/recycled products into the manufacturer of their components or products. Cleaning and maintenance instructions shall be included. Design calculations which demonstrate that the proposed floor system meets requirements for seismic loading, prepared in accordance with subparagraph Underfloor Bracing under paragraph PANEL SUPPORT SYSTEM and ICBO Bldg Code. Certified copies of test reports may be submitted in lieu of calculations.

SD-04 Drawings

Raised Floor System; [_____].

Drawings showing layout of the work, sizes and details of components, details at floor perimeter, bracing to resist seismic or other lateral loads, typical cutout details including size and shape limitation, method of grounding, description of shop coating, and installation height above structural floor.

SD-09 Reports

Tests; [_____]. Testing of Electrical Resistance; [_____].

Certified copies of test reports from an approved testing laboratory, attesting that the proposed floor system components meet the performance requirements specified.

SD-13 Certificates

Raised Floor System; [_____].

Certificate of compliance attesting that the raised floor system meets specification requirements.

SD-14 Samples; [_____].

One sample of each panel type and suspension system proposed for use.

1.4 DELIVERY, STORAGE, AND HANDLING

Materials shall be stored in original protective packaging in a safe, dry, and clean location and shall be handled in a manner to prevent damage. Panels shall be stored at temperatures between 40 and 90 degrees F, and between 20 percent and 70 percent humidity.

1.5 EXTRA MATERIALS

Spare floor panels, spare complete pedestal assemblies, and spare stringers shall be furnished at the rate of one space for each 100 or fraction thereof required.

1.6 OPERATION AND MAINTENANCE MANUALS

Provide maintenance instructions for proper care of the floor panel surface. When conductive flooring is specified, require submittal of maintenance instructions to identify special cleaning and maintenance requirements to maintain "conductivity" properties of the panel finish.

PART 2 PRODUCTS

****

NOTE: The designer should consider incorporating, when possible, any design provisions which encourage use of innovative construction materials or techniques which are environmentally sensitive, take advantage of recycled materials, and conserve our natural resources.

****

2.1 FLOOR PANELS

2.1.1 Panel Construction

****

NOTE: There are five basic floor panel types: aluminum, hollow formed steel, metal-clad cementitious fill, metal-clad wood core, and concrete. Nonferrous materials should be used in areas where there is potential for damage by rust oxides or paint flakes. In accordance with CISCA Test Method, hollow panels should have a safety factor of 2 and filled panels a safety factor of 3

in terms of ultimate load.

The standard panel size of 600 by 600 mm for metric projects and 24 by 24 inches for imperial unit projects will normally be used. Nonstandard panels (450, 750 and 900 mm) (18, 30, and 36 inches square) are available where required to match existing floor systems or as required to satisfy special requirements.
****

Except for edge panels, panel size shall be [24 by 24] [_____] inches. Finished panels shall be within a 0.010 inch tolerance of the nominal size, and shall be square within a tolerance of 0.015 inch measured corner-to-corner. The top surface of panels shall be flat within a 0.020 inchtolerance measured corner-to-corner. Panels shall be permanently marked to indicate load rating and model number.

2.1.1.1 Aluminum Panels

****
NOTE: Die-cast aluminum panels are lightweight, have very little variation in dimension from panel to panel, and are acceptable in environments where nonferrous materials are required (e.g., Magnetic Resonance Imagery rooms), but they tend to be more expensive than other types of panels.

Die-cast aluminum panels are normally used as a stringerless system. Stringers, when required, are fastened to the top of the pedestal shaft.
****

Aluminum panels shall be of die-cast or extruded construction.

2.1.1.2 Hollow Formed Steel Panels

****
NOTE: Die-formed hollow steel panels perform best under static loads and should not be used under dynamic (rolling) loads. These panels are more economical than other types of panels and can be provided by most flooring system manufacturers.
****

Steel panels shall be of die-formed construction, consisting of a flat steel top sheet welded to one or more formed steel stiffener sheets. Panels shall be chemically cleaned, bonderized, and painted with the manufacturer's standard finish.

2.1.1.3 Metal-Clad Cementitious Fill Panel (Composite Panels)

****
NOTE: Cementitious core filled panels are enclosed in steel sheeting and are designed to provide improved resistance to rolling and impact loads.

Specific strength and load requirements should be specified wherever it is a critical concern. These panels are quiet due to their mass, but usually cost slightly more than the standard formed steel panels.

There is some concern that the fill material may deteriorate when subjected to repeated loading cycles, and the cut edges could introduce dust into the underfloor space. Where the underfloor space will be a plenum, or where dust-sensitive computer equipment is to be installed, verify that the composite panel is acceptable to the Using Agency.

Current Air Force criteria does not permit the composite panel.
****

Composite panels shall be of die-formed steel construction totally enclosing the panel, including the top surface. The void spaces between the top sheet and the formed steel bottom sheet shall be completely filled with an incombustible cementitious or concrete material.

2.1.1.4 Metal-Clad Wood Core Panels

****
NOTE: Wood core panels consist of a core of particleboard with an overlapping skin of galvanized steel. The wood core is a good sound deadener and insulator and increases resistance to rolling loads. Wood core panels are the most economical to procure.

Although the core material is combustible, the composite panel with bonded steel for face sheets when tested in accordance with the NFPA 225, revealed the composite panel to be noncombustible with a flame spread index of 0, a smoke developed index of 10, and to have a Class A fire rating.

Wood core panels can be easily cut and trimmed; however, doing so causes loss of fire retardancy and UL rating. The edges of wood core panels must be protected from moisture in order to prevent warping.
****

Wood core panels shall have cores of wood particleboard conforming to ANSI A208.1, Grade 1-M-3, or of plywood conforming to DOC PS 1, EXT-DFPA-C-C. The core shall be not less than 1 inch thick, and shall be faced on both sides with structurally bonded zinc-coated steel sheets not lighter than 24 gauge. All edges and corners shall be sealed with zinc-coated steel or extruded aluminum. The completed panels shall have a flame spread rating of 25 or less when tested in accordance with ASTM E 84.

2.1.1.5 Concrete Panels

****
NOTE: Lightweight concrete panels are either solid

or metal clad. They perform well under dynamic loadings with little deformation and their weight is approximately 195 kg/m^2 (40 psf). They are primarily used in office flooring and are similar in cost to cementitious fill panels.
****

Concrete panels shall be of lightweight structural concrete with either structural reinforcing or a die-formed, electro-galvanized steel bottom pan. All concrete surfaces including those resulting from field cuts shall be sealed with the manufacturer's standard sealer before covering the surfaces with other materials.

2.1.2   Floor Covering

Floor panels shall be surfaced with materials firmly bonded in place with waterproof adhesive. The electrical resistance shall remain stable over the life expectancy of the floor covering. Any antistatic agent used in the manufacturing process shall be an integral part of the material, and shall not be surface applied. Bolt heads or similar attachments shall not rise above the traffic surface.

2.1.2.1   High Pressure Laminate

****
NOTE: High pressure laminate is the standard surfacing material and is preferred where cost is not an overriding factor.
****

High pressure laminate surfacing shall conform to NEMA LD 3, Grade HW 62. Total system electrical resistivity from the wearing surface of the floor to the ground connection shall be between 150,000 ohms and 20,000,000,000 ohms.

2.1.2.2   Conductive Surfacing

****
NOTE: Conductive floor surfacing material is used where minimal electrical resistance is desired, mainly in clean rooms, hospital operating rooms, etc. The surface does not perform well under the application of heavy concentrated loads.

When conductive floor surfacing is specified, require submittal of maintenance instructions as per paragraph OPERATION AND MAINTENANCE MANUALS to identify special cleaning and maintenance requirements to maintain "conductive" properties of the panel finishes.
****

Conductive surfacing shall conform to NEMA LD 3, Grade HW 62. The total system electrical resistivity from the wearing surface of the floor to the ground connection shall be between 25,000 ohms and 1,000,000 ohms.

2.1.2.3   Conductive High Pressure Laminate

****
NOTE: Conductive high pressure laminate floor surfaces combine the electrical resistivity qualities of the conductive surfacing with the wear characteristics of high pressure laminate.
****

Conductive high pressure laminate floor surfacing shall conform to FS SS-T-312, Type III, Vinyl Tile and UL 779. The total system electrical resistivity from the wearing surface of the floor to the ground connection shall be between 25,000 ohms and 1,000,000 ohms.

2.1.2.4 Vinyl Composition Tile

****
NOTE: Vinyl composition tile is the lowest cost surfacing tile, however the availability of tile meeting the electrical resistance requirements is limited. Normally either Composition 1 or 2 will be specified; however Composition 1 should be specified when the Using Agency desires an asbestos-free material. FS SS-T-312, Type II - Rubber or Type III - Vinyl tile may be specified when requested; however the electrical resistance characteristics should be verified before use. At installations where operating personnel will be required to wear conductive footwear to prevent static electricity buildup, conductive vinyl tile flooring may be necessary to satisfy the conductivity requirements.
****

Vinyl composition tile surfacing shall be 1/8 inch thick conforming to FS SS-T-312, Type IV, Composition [1] [1 or 2]. Tiles may be approximately 12 inches square or may be the full size of the panel.

2.1.2.5 Carpet

****
NOTE: Carpet should be specified only when requested by the Using Agency. Carpet may be bonded to the panels, or may be installed as loose-laid carpet squares. Where loose-laid carpet squares are used, delete the test for floor covering bond strength specified in paragraph BOND STRENGTH OF FLOOR COVERING. Carpet squares may be placed with carpet joints in alignment with panel joints, or may be placed with carpet joints at the panel midpoint Color and pattern of carpet will be in accordance with current Air Force or Army carpet policy.
****

Carpet surfacing shall be [factory] [field] installed using one full carpet square per panel. Carpet shall be nylon filament, loop pile, minimum 24 ounce per square yard, minimum density 4000, and without cushion. Carpet shall conform to ASTM E 648 with a minimum average critical radiant flux of

0.25 watts per square centimeter. Static control shall be less than 2.0 kV at 20 percent relative humidity at 70 degrees F.

2.1.3 Edge Strip

Panels shall be edged with extruded vinyl edge strips secured in place with mechanical interlock or adhesive bond, or shall be of a replaceable type. Top of strip shall be approximately 1/8 inch wide, and shall be flush with the floor surfacing.

2.1.4 Accessories

****

NOTE: Perforated panels are preferred for use in areas with hard surfaces such as high pressure laminates, and grilles or registers are preferred in areas with carpet

****

Registers, grilles, perforated panels, and plenum dividers shall be provided where indicated, and shall be the manufacturer's standard type. Registers, grilles, and perforated panels shall be designed to support the same static loads as floor panels without structural failure, and shall be capable of delivering the air volumes indicated. Registers and perforated panels shall be 25 percent open area and shall be equipped with adjustable dampers.

2.1.5 Resilient Base

Base shall be manufacturers standard [rubber] [or] [vinyl] [straight style (installed with carpet)] [coved style (installed with resilient flooring)]. Base shall be [4] [6] inches high and a minimum 1/8 inch thick. [Performed outside] [Job Formed] corners shall be furnished.

2.1.6 Lifting Device

Each individual room shall be provided with one floor panel lifting device standard with the floor manufacturer. A minimum of two devices shall be furnished.

2.2 PANEL SUPPORT SYSTEM

2.2.1 Pedestals

Pedestals shall be of steel or aluminum or a combination thereof. Ferrous materials shall have a factory-applied corrosion-resistant finish. Pedestal base plates shall provide a minimum of 16 square inches of bearing surface and shall be a minimum of 1/8 inch thick. Pedestal shafts shall be threaded to permit height adjustment within a range of approximately 2 inches, to permit overall floor adjustment within plus or minus 0.10 inch of the required elevation, and to permit leveling of the finished floor surface within 0.062 inch in 10 feet in all directions. Locking devices shall be provided to positively lock the final pedestal vertical adjustments in place. Pedestal caps shall interlock with [panels] [stringers] to preclude tilting or rocking of the panels.

2.2.2 Stringers

Stringers shall be of rolled steel or extruded aluminum, and shall interlock with the pedestal heads to prevent lateral movement.

2.2.3 Underfloor Bracing

****
NOTE: Provide seismic requirements, if a Government designer (Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not provided. Section 13080, properly edited, must be included in the contract documents.
****

Special bracing to resist the effects of seismic or other forces shall be in accordance with Section 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT [as shown on the approved detail drawings].

2.3 FASCIA

Aluminum or steel fascia plates shall be provided at open ends of floor, at sides of ramps and steps, and elsewhere as required to enclose the free area under the raised floor. Steel plates shall have a factory applied baked enamel finish. Finish on aluminum plates shall be as standard with the floor system manufacturer. Fascia plates shall be reinforced on the back, and shall be supported using the manufacturer's standard lateral bracing at maximum 4 feet on center. Trim, angles, and fasteners shall be provided as required.

2.4 STEPS AND RAMPS

Steps and ramps shall be securely fastened to the raised floor system and to the structural floor. Construction shall include standard floor system components and custom components as required, and shall include all supports, fasteners, and trim necessary for a finished installation. Step nosings, threshold strips, and floor bevel strips shall be cast or extruded aluminum with nonslip traffic surfaces.

2.4.1 Steps

Height of risers shall not exceed 7 inches. Steps shall be designed to support a uniform load of 150 pounds per square foot. Treads shall be surfaced with the manufacturer's standard nonslip floor finish.

2.4.2 Ramps

Slope of ramps shall not exceed 1 inch rise to 12 inches of run. Ramps shall be designed to support the same loads as specified for floor panels. Ramps shall be surfaced with the manufacturer's standard nonslip floor finish.

2.5 RAILINGS

Railings shall be the double rail and post type, fabricated of at least 1 inch round or square seamless aluminum tubing with a satin natural anodized finish. At steps and ramps, the top rail shall be approximately 36 inches high and parallel to the incline. The top rail shall be 42 inches high at open ends of the floor. Guardrails shall have intermediate rails or an ornamental pattern such that a sphere 4 inches in diameter cannot pass thru.

2.6 TESTS

Raised flooring shall be factory tested by an independent laboratory at the same position and maximum design elevation and in the same arrangement as shown on the drawings for installation so as to duplicate service conditions as much as possible.

2.6.1 Load Tests

Floor panel, stringer, and pedestal testing shall be conducted in accordance with CISCA Access Floors.

2.7 Test for Bond Strength of Factory Installed Floor Covering

The test panel shall be supported on pedestals and stringers as specified for the installed floor. The supports shall be braced as necessary to prevent sideways movement during the test. A test load of 1000 pounds shall be imposed on the test assembly through a hard plastic caster 3 inches in diameter and 1 inchwide. The caster shall be rolled completely across the center of the panel. The panel shall withstand 20 passes of the caster with no delamination or separation of the covering.

2.8 COLOR

Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

PART 3 EXECUTION

3.1 INSTALLATION

The floor system shall be installed in accordance with the manufacturer's instructions and with the approved detail drawings. Open ends of the floor, where the floor system does not abut wall or other construction, shall have positive anchorage and rigid support. Areas to receive raised flooring shall be maintained between 60 and 90 degrees F, and between 20 percent and 70 percent humidity for 24 hours prior to and during installation.

3.1.1 Preparation for Installation

The area in which the floor system is to be installed shall be cleared of all debris. Structural floor surfaces shall be thoroughly cleaned and all dust shall be removed. Floor coatings required for dust or vapor control shall be installed prior to installation of pedestals only if the pedestal adhesive will not damage the coating. If the coating and adhesive are not compatible, the coating shall be applied after the pedestals have been installed and the adhesive has cured.

3.1.2 Pedestals

****

NOTE: Seismic calculations must be made by the designer to determine if adhesives or anchors are to be used, pedestal adhesives must be capable of securing pedestals in place with sufficient bonding strength to resist an overturning force of 113 N-m (1000 inch-pounds). If the calculations indicate the overturning force is greater than 113 N-m (1000

inch-pounds) steel expansion anchors will be used.
****

Pedestals shall be accurately spaced, and shall be set plumb and in true alignment. Base plates shall be in full and firm contact with the structural floor, [and shall be secured to the structural floor with adhesive.] [and shall be secured to the structural floor with steel expansion anchors.]

3.1.3 Stringers

Stringers shall be interlocked with the pedestal caps to preclude lateral movement, and shall be spaced uniformly in parallel lines at the indicated elevation.

3.1.4 Auxiliary Framing

Auxiliary framing or pedestals shall be provided around columns and other permanent construction, at sides of ramps, at open ends of the floor, and beneath panels that are substantially cut to accommodate utility systems. Special framing for additional lateral support shall be as shown on the approved detail drawings.

3.1.5 Panels

The panels shall be interlocked with supports in a manner that will preclude lateral movement. Perimeter panels, cutout panels, and panels adjoining columns, stairs, and ramps must be fastened to the supporting components to form a rigid boundary for the interior panels. Floors shall be level within 1/16 inch measured with a 10 foot straightedge in all directions. Cut edges of steel and wood-core panels shall be painted as recommended by the panel manufacturer. Cut edges of composite panels shall be coated with a silicone rubber sealant or with an adhesive recommended by the panel manufacturer. Extruded vinyl edging shall be secured in place at all cut edges of all panel cut-outs to prevent abrasion of cables. Where the space below the floor is a plenum, cutouts for conduit and similar penetrations shall be closed using self-extinguishing sponge rubber.

3.1.6 Resilient Base

Base shall be provided at vertical wall intersections. Cracks and voids in walls and other vertical surfaces to receive base shall be filled with an approved filler. The base shall be applied after the floor system has been completely installed. Base shall be applied with adhesive in accordance with the manufacturer's recommendations.

3.1.7 Fascia Plates

Exposed floor ends and exposed openings of ramps and stairs shall be covered with aluminum or steel closures.

3.1.8 Repair of Zinc Coating

Zinc coating that has been damaged, and cut edges of zinc-coated components and accessories, shall be repaired by the application of a galvanizing repair paint. Areas to be repaired shall be thoroughly cleaned prior to application of the paint.

3.2 TESTING OF ELECTRICAL RESISTANCE

Testing of electrical resistance in the completed installation shall be conducted in the presence of the Contracting Officer. Testing shall be in accordance with NFPA 99 modified by placing one electrode on the center of the panel surface and connecting the other electrode to the metal flooring support. Measurements shall be made at five or more locations. Each measurement shall be the average of five readings of 15 seconds duration at each location. During the tests, relative humidity shall be 45 to 55 percent and temperature shall be 69 to 75 degrees F. The panels used in the testing will be selected at random and will include two panels most distant from the ground connection. Electrical resistance shall be measured with instruments that are accurate within 2 percent and that have been calibrated within 60 days prior to the performance of the resistance tests. The metal-to-metal resistance from panel to supporting pedestal shall not exceed 10 ohms. The resistance between the wearing surface of the floor covering and the ground connection, as measured on the completed installation, shall be in accordance with paragraph FLOOR COVERING.

3.3 CLEANING AND PROTECTION

3.3.1 Cleaning

The space below the completed floor shall be free of all debris. Before any traffic or other work on the completed raised floor is started, the completed floor shall be cleaned in accordance with the floor covering manufacturer's instructions.

3.3.2 Protection

Traffic areas of raised floor systems shall be protected with a covering of building paper, fiberboard, or other suitable material to prevent damage to the surface. Cutouts shall be covered with material of sufficient strength to support the loads to be encountered. Plywood or similar material shall be placed on the floor to serve as runways for installation of heavy equipment. Protection shall be maintained until the raised floor system is accepted.

3.4 FIRE SAFETY

An automatic detection system shall be installed below the raised floor meeting the requirements of NFPA 75 paragraph 5-2.1 and shall sound an audible and visual alarm. Air space below the raised floor shall be subdivided into areas not exceeding 10,000 square feet by tight, noncombustible bulkheads. All penetrations for piping and cables shall be sealed to maintain bulkhead properties.

-- End of Section --

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DEPARTMENT OF THE ARMY — **CEGS-10440 (June 1998)**

U.S. ARMY CORPS OF ENGINEERS — **----------------------**

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GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 1 (September 1998)

Latest Notice change indicated by CHG tags.

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SECTION 10440

INTERIOR SIGNAGE
06/98

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NOTE: This guide specification covers the requirements for common types of signs, dimensional letters, and metal plaques used inside buildings. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL: http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

****

NOTE: This section covers some of the more common interior sign types. When other sign types are to be used, specifications will be modified accordingly. Buildings not excluded by AEI Design Criteria will be accessible in accordance with 36 CFR, Part 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities.

Drawings will indicate location, dimensions,

elevations, schedules, content, details and such other information as required to indicate the extent of the work. The same terminology or titles used in the specification, for the different types of signage, will be used on the drawings and schedules.

Product selections shall be based on esthetic values, appearance, and cost as related to project needs.

Where appropriate for medical facilities, include the following requirements for signage:

1. Permanent information on room identification signs will have 0.80 mm (0.0312 inch) raised characters and accompanying Grade 2 Braille. Permanent information includes the room number on all room identification signs, symbol and message on toilet rooms, message on janitor closets, mechanical/electrical and communications rooms, and message on stairs.

2. Room numbering for spaces within the medical facility will be determined jointly by the using facility and the design team. User room number will be different than architectural room number (see MIL-HDBK 1191, 4.15.3). Room numbering will be consistent throughout the facility, with odd numbers on the right and even numbers on the left. For inpatient medical facilities, rooms with audiovisual nurse call need to have a unique user room number, since audiovisual nurse call is tied into a digital paging system. For outpatient clinics, rooms with tonevisual nurse call, do not need a unique user room number, since tonevisual nurse call is hardwired to a panel located at a nursing station. Room numbering should address the following issues:

a. Wayfinding within clinics and other departments (user room #).

b. Facility Maintenance (architectural room #).

c. Audiovisual Nurse Call (inpatient) (unique user room #).

d. Tonevisual Nurse Call (outpatient) (user room #).

3. The use of symbols/graphics on interior signage will be limited. International symbols and graphics will be used where needed. Recommended symbols include men/women symbol for toilet rooms and showers, men/women symbol with key for locker rooms,

telephone symbol for public telephone areas, parking symbol (upper case P with circle), information (?), radiation symbol, biohazard symbol, and handicap symbol.

4. Signage background color should be in high contrast with signage copy (note: dark background with white copy is preferred).

5. Arrow placement order on interior signage will comply with MIL-HDBK 1191, 4.15.2.2. Left pointing arrows at top of sign, followed by up pointing arrows, then right pointing arrows at bottom of sign. Example follows:

< EMERGENCY
^ Orthopedic Clinic
> Admissions

6. Signage schedule should be provided in electronic spreadsheet format. Schedule will include architectural room number, user room number, type of sign, message, symbol (if needed), color, and mounting location.

7. Building directories and accompanying orientation maps for the medical facility will be determined jointly by the using facility and the design team. Orientation maps, if required, will be included as part of the interior signage package, and should be of the same manufacturer. Include international symbols for information (?), parking areas (upper case P within circle), public toilet rooms, public telephones, and graphic north arrow on orientation maps. Orientation map is to be positioned so that building left is viewer's left.

8. Large, easy to read signs over reception counters, check-in counters, information desks, or departments will be provided. Signs should be either ceiling mounted or affixed to soffit directly above counters.

9. Room identification signs should be 20.32 cm x 20.32 cm (8 x 8 inch) or 22.86 cm x 22.22.86 cm (9 x 9 inch). Justification of room number and message will be flush left.

10. Interior stairwell signage will be provided in accordance with Life Safety Code NFPA 101, Chapter 5, and applicable occupancy chapters. Clearly define interstitial spaces or other doorways within stairwell that do not lead to a horizontal exitway with signage that states "Not an Exit".

11. Fire evacuation signs will be provided in accordance with the local Fire Marshal, if required.

12. Overhead directional signs should not block fire exit signs.

13. Signage will clearly define all staff, public, or patient toilet rooms.

14. Use of personal names in interior signage package is discouraged. If personal names are required, changeable message strips will be used.

15. Requirements for sign-making equipment or software will be determined jointly by the using facility and the design team.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF-45	(1980; R 1993) Designation System for Aluminum Finishes
AA PK-1	(1996) Registration Record of Aluminum Association Alloy Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings and Ingot

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 605	(1992; Addenda Jan 1995) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(1984; Rev 1994) Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	(1995) Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C 1036	(1991; R 1997) Flat Glass

AMERICAN WELDING SOCIETY (AWS)

AWS D1.2	(1990) Structural Welding Code - Aluminum

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996; Errata 96-4) National Electrical Code

1.2 GENERAL

Interior signage shall be of the design, detail, sizes, types, and message content shown on the drawings, shall conform to the requirements specified, and shall be provided at the locations indicated. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation.

1.2.1 Character Proportions and Heights

Letters and numbers on indicated signs in handicapped-accessible buildings, which do not designate permanent rooms or spaces, shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on indicated signs shall be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case letter "X". Lower case characters are permitted. Suspended or projected overhead signs shall have a minimum character height of 3 inches.

1.2.2 Raised and Brailled Characters and Pictorial Symbol Signs (Pictograms)

Letters and numbers on indicated signs which designate permanent rooms and spaces in handicapped-accessible buildings shall be raised 1/32 inch upper case, sans serif or simple serif type and shall be accompanied with Grade 2 Braille. Raised characters shall be at least 5/8 inch in height, but no higher than 2 inches. Pictograms shall be accompanied by the equivalent verbal description placed directly below the pictogram. The border dimension of the pictogram shall be 6 inches minimum in height. Indicated accessible facilities shall use the international symbol of accessibility.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Interior Signage; [_____].

Manufacturer's descriptive data, catalogs cuts, installation and cleaning instructions.

SD-04 Drawings

Interior Signage; [_____].

Drawings showing elevations of each type of sign, dimensions, details and methods of mounting or anchoring, shape and thickness of materials, and details of construction. A schedule showing the location, each sign type, and message shall be included.

SD-14 Samples

Interior Signage; [______].

One sample of each of the following sign types showing typical quality and workmanship. The samples may be installed in the work, provided each sample is identified and location recorded.

a. Directional sign.

b. Door identification sign.

c. [_____].

[Two] [_____] samples of manufacturer's standard color chips for each material requiring color selection.

SD-19 Operation and Maintenance Manuals

Interior Signage; [_____].

[Six] [_____] copies of operating instructions outlining the step-by-step procedures required for system operation shall be provided. The instructions shall include simplified diagrams for the system as installed. [Six] [_____] copies of maintenance instructions listing routine procedures, repairs, and guides shall be provided. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS", name and location of the facility, name of the Contractor, and contract number.

1.4 QUALIFICATIONS

Signs, plaques, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening.

1.5 DELIVERY AND STORAGE

Materials shall be delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area in accordance with manufacturer's instructions.

1.6 EXTRA STOCK

****

NOTE: A sufficient number of identification signs and letters for future use for changes and message replacement shall be specified.

****

The Contractor shall provide [_____] extra frames and extra stock of the following: [[_____] blank plates of each color and size for sign types [_____].] [[_____] pressure-sensitive letters in each color and size for sign type [_____].] [[_____] changeable message strips for sign type [_____].]

PART 2 PRODUCTS

****

NOTE: Omit signage systems, directories, etc., not required for project. Coordinate electrical requirements with Division 16 and available electric service.

****

2.1 ROOM IDENTIFICATION/DIRECTIONAL SIGNAGE SYSTEM

****

NOTE: Drawings will indicate in sufficient detail whether a modular interchangeable component system is required for the project.

Melamine plastic (MP) is a tough phenolic core material that is for interior and non-direct sun exterior usage and is recommended for raised lettering and braille. The engraving stock (ES) plastic is not recommended for raised lettering and braille.

****

Signs shall be fabricated of [Type ES/MP laminated thermosetting plastic suitable for engraving] [or] [acrylic plastic conforming to ANSI Z97.1] [extruded aluminum conforming to ASTM B 221].

2.1.1 Standard Room Signs

Signs shall consist of [gloss] [matte] finish [acrylic plastic] [laminated thermosetting Type MP plastic] [_____]. [Units shall be frameless] [Frames shall be [aluminum] [wood] [molded acrylic]]. Corners of signs shall be [squared] [[3/8] [1/2] [3/4] [_____] inch radius] [as shown].

2.1.2 Changeable Message Strip Signs

****

NOTE: Where conditions require frequent changes, laminated signs may be used to allow for message replacement. This type also allows for two message signs such as "occupied-vacant." Details of requirements shall be shown on drawings.

Polycarbonate is shatter resistant but susceptible to UV radiation. Cast acrylic is more commonly used and is easy to work with but does not have the shatter resistance of polycarbonate. Select sign material based on exposure and strength requirements.

****

Changeable message strip signs shall consist of [polycarbonate] [cast acrylic] [_____] [laminated thermosetting Type MP plastic] [Type [ES] [MP] plastic captive message [magnetic back] [slider sign]] [_____] face with message slots and associated end caps, as detailed, for insertion of changeable message strips. Size of signs shall be as shown on the drawings. Individual message strips to permit removal, change, and reinsertion shall be provided as detailed. Corners of signs shall be [squared] [[3/8] [1/2] [3/4] [_____] inch radius].

2.1.3 Type of Mounting For Signs

Extruded aluminum brackets, mounted as shown, shall be furnished for hanging, projecting, and double-sided signs. Mounting for framed, hanging, and projecting signs shall be by mechanical fasteners. Surface mounted signs shall be provided with [1/16 inch thick vinyl foam tape] [or] [countersunk mounting holes in plaques and mounting screws] [_____]. Sign inserts shall be provided with 1/16 inch thick foam tape.

2.1.4 Graphics

****

NOTE: Edit the following requirements as necessary for the project.

****

Signage graphics for modular identification/directional signs shall conform to the following:

[[Cast] [Fabricated] aluminum letters [1/8] [1/4] [_____] inch thick shall be provided and fastened to the message panel with concealed fasteners. Aluminum letter finish shall be as specified. Letters shall project 1/32 inch minimum from face of panel.]

[Pressure sensitive prespaced and prealigned precision computer cut vinyl letters on release paper shall be provided. Edges and corners of finished letter forms and graphics shall be true and clean. Vinyl sheeting for graphics shall be 5 to 7 year premium type and shall be a minimum 0.003 inch film thickness. Film shall include a precoated pressure sensitive adhesive backing.]

[Message shall be applied to panel using the silkscreen process. Silkscreened images shall be executed with photo screens prepared from original art. Handcut screens will not be accepted. Original art shall be defined as artwork that is a first generation reproduction of the specified art. Edges and corners shall be clean.]

[Acrylic letters [1/8] [1/4] [_____] inch thick and chemically welded to 0.125 inch thick acrylic backup sheet.]

[Graphics shall be raised 1/32 inch with background [painted with low VOC paint] [or] [engraved exposed laminate].]

2.2 BUILDING DIRECTORIES

Building directories shall be lobby directories or floor directories, and shall be provided with a changeable directory listing consisting of the areas, offices and personnel located within the facility. Dimensions, details, and materials of sign shall be as shown on the drawings. Where required, message content shall be as shown on drawings and schedule.

2.2.1 Header Panel

Header panel shall [have background metal to match frame and shall have raised letters] [be acrylic with raised acrylic letters] [be ES/MP plastic with raised letters] [_____].

2.2.2 Doors

2.2.2.1 Door Glazing

Door glazing shall be [in accordance with ASTM C 1036, Type 1, Class 1, Quality 3, minimum 1/8 inch thick] [clear acrylic sheet 3/16 inch thick conforming to [_____]] [clear polycarbonate sheet 3/16 inch thick] [_____].

2.2.2.2 Door Construction

Extruded aluminum door frame shall be of same finish as surrounding frame. Corners shall be mitered [, reinforced] [, welded], and assembled with concealed fasteners. Hinges shall be standard with the manufacturer, in finish to match frames and trim. Glazing shall be set in frame with resilient glazing channels.

2.2.2.3 Door Locks

Door locks shall be manufacturer's standard, and shall be keyed alike.

2.2.3 Fabrication

Extruded aluminum frames and trim shall be assembled with corners [reinforced] [welded] and mitered to a hairline fit, with no exposed fasteners.

2.2.4 Illuminated Units

****

NOTE: Coordinate illumination with Division 16 and available electric service.

****

Illuminated directory units shall have concealed internal [top] [back] lighting with [rapid start fluorescent tube lamp] [_____], internal wiring, and lead at wire for connection. Electrical work shall comply with NFPA 70 and shall be UL or FM listed.

2.2.5 Negative Graphics Directory System

Directory shall consist of internally illuminated unit with backlit photo negative directory strips and a black background. Unit shall have a tinted [tempered safety solar glass] [_____] door. Design of unit shall be as shown.

2.2.5.1 Construction

The directory shall be constructed of an aluminum [4] [6] inch deep frame with satin [black] [dark bronze] [_____] anodized finish. Unit shall be [[semi] [fully] recessed] [[pedestal] [_____]] mounted. Unit shall have a [3] [_____] inch high header lettering as shown. Unit shall have a [_____] 3/8 inch face door frame with concealed hinges and locking system. Door frame shall be [aluminum with [satin] [black] [dark bronze]] [solid [polished] [satin] [chrome plated] brass] [solid architectural bronze] [_____].

2.2.5.2 Message Strips

****

NOTE: Photo negative replaceable message strips are available from manufacturer via 7-10 day delivery, FAX order, or coupon book order.

****

Message strips shall be photo negative type updatable by user with book reordering and with 7 to 10 day delivery. Message strips shall be [3/8 x [3.5] [7] [11] inches] [1/2 x [7] [11] inches] [_____].

2.2.6 Changeable Letter/Message Strip Directory System

Directory shall consist of [an internally illuminated] [a non-illuminated] unit with [step or groove, laser or rotary engraved removable name strips] [felt grooved for changeable letters] [cast vinyl to receive molded changeable letter tiles] [laminated plastic magnetic back message strips]. Design of unit shall be as shown in the drawings.

2.2.6.1 Construction

The directory shall be constructed of an aluminum [2] [_____] inch deep frame with satin [black] [dark bronze] [_____] anodized finish. Unit shall be [surface] [[semi] [fully] recessed] [[pedestal] [_____]] mounted. Unit shall have a [3] [_____] inch high header with lettering as shown. Unit shall have a [3/8] [_____] inch face [[concealed hinge door and locking system] [lift off frame]] with [[tempered safety glass] [_____]] [fixed frame] [_____]. Door frame shall be [aluminum with satin [black] [dark bronze]] [solid [polished] [satin] [chrome plated] brass] [solid architectural bronze] [_____].

2.2.6.2 Message Strips

[Namestrips shall be updatable by user with coupon book reordering and with 5 to 7 day delivery. Namestrips shall be [[acrylic] [_____]] [sized per manufacturer's standard] [_____].] [Namestrips shall be felt grooved background with changeable upper and lower case [Helvetica Medium] [_____] letters. Tabbed vinyl letters and numbers shall be furnished in accordance with the [drawings] [and] [schedule].]

2.2.7 Touchscreen Electronic Directory System

****
NOTE: The touchscreen electronic directory system is a limited usage item and must be fully justified prior to being specified.
****

Touchscreen electronic directory system shall be a complete turnkey system consisting of touchscreen monitor, processor, update terminal with software connected through a [telephone network] [or] [local area network (LAN)]. The system shall be in compliance with the layout and number shown. Electrical equipment shall be UL listed and shall comply with NFPA 70.

2.2.7.1 Directory Unit

Directory unit shall consist of [[1] [_____]] [14] [16] [_____] inch touchscreen monitor and membrane keypad with [alphabetic 28] [alphanumeric 38] [alphabetic braille 30] keys. Screen resolution shall be [SVGA [800 x 600] [1280 x 1024]] [_____]. Monitor shall be full color. Processor shall be Pentium 75 or better with sound peripherals and have a listing capacity of [96,000] [1,000,000] [_____] items. Directory unit shall be of design and finishes as shown.

2.2.7.2 Update Terminal

Update terminal unit shall consist of a [12] [14] [_____] inch color monitor with [84] [101] key keypad. Unit shall have a 132 column report printer. Unit shall include a Pentium 75 or better PC processor with floppy disk from update terminal to each directory. System shall include [network from update to each directory] [and] [network from mainframe to update terminal to each directory]. Communications shall be over a telephone network or a LAN.

2.3 METAL PLAQUES

2.3.1 Cast Metal Plaques

2.3.1.1 Fabrication

Cast metal plaques shall have the logo, emblem and artwork cast in the [bas relief] [flat relief] [_____] technique. Plaques shall be fabricated from [prime aluminum] [bronze] [yellow brass].

2.3.1.2 Border

Border shall be [flat band] [plain edge] [bevel] [custom ornamental] [_____].

2.3.1.3 Background

Background texture shall be [leather] [fine pebble] [_____].

2.3.1.4 Mounting

Mounting shall be [concealed] [rosettes and anchors] [rosettes and toggle bolts] [invisible] [_____].

2.3.1.5 Finish

Finishes shall consist of [aluminum light colored sandblasted background. Letters shall be satin polished and entire plaque shall be sprayed with two coats of clear lacquer.] [aluminum with background sprayed dark gunmetal colored lacquer. Letters shall be satin polished and entire plaque sprayed with two coats clear lacquer.] [bronze with dark finish oxidized background. Letters shall be satin polished and entire plaque sprayed with two coats of clear lacquer.] [[aluminum] [bronze] with background sprayed with standard color. Letters shall be satin polished.]

2.3.2 Chemically Etched Metal Plaques

2.3.2.1 Fabrication

Plaque shall be chemically [single-] [double-] etched one-piece [brass] [bronze] [zinc] [magnesium] [_____] [0.032] [0.064] [0.125] [0.250] inch thick.

2.3.2.2 Finish

[Single-etched raised areas shall be in [gold-tone] [silver-tone] [bronze-tone] finish and recessed areas shall be colorfilled.] [Double-etched raised areas shall be [gold-tone] [silver-tone] and recessed textured areas shall be [gold-tone] [silver-tone] colorfilled.]

2.3.3 Frost and Surface Oxidized Plaques

2.3.3.1 Fabrication

Plaque shall be frosted and surface oxidized one-piece [anodized aluminum] [brass] [bronze] [stainless steel] [0.040] [0.125] inch thick.

2.3.3.2 Finish

[Material finish shall be [satin] [polished].] [Frosted areas shall be oxidized [black for aluminum or stainless steel] [or] [black or brown, for brass or bronze].]

2.4 DIMENSIONAL BUILDING LETTERS

****

NOTE: These letters are for direct application to interior building surfaces. Drawings must show mounting type details.
****

2.4.1 Fabrication

Letters shall be fabricated from [[cast aluminum] [cast bronze]] [[0.090] [0.125] inch aluminum sheet] [extruded aluminum] [injection molded plastic]. Letters shall be cleaned by chemical etching or cleaned ultrasonically in a special degreasing bath. Letters shall be packaged for protection until installation.

2.4.2 Typeface

Typeface shall be [helvetica medium] [_____].

2.4.3 Size

Letter size shall be [_____].

2.4.4 Finish

[Anodized aluminum] [Baked enamel or two-component acrylic polyurethane] [[Polished] [Oxidized] bronze with clear coat] finish shall be provided.

2.4.5 Mounting

[Threaded studs] [Steel U-bracket, cap screws, and expansion bolts] of number and size recommended by manufacturer, shall be supplied for concealed anchorage. Letters which project from the mounting surface shall have [stud spacer sleeves] [_____]. Letters, studs, and sleeves shall be of the same material. Templates for mounting shall be supplied.

2.5 ALUMINUM ALLOY PRODUCTS

Aluminum extrusions shall be at least 1/8 inch thick, and aluminum plate or sheet shall be at least 0.0508 inch thick. Extrusions shall conform to ASTM B 221; plate and sheet shall conform to ASTM B 209. Where anodic coatings are specified, alloy shall conform to AA PK-1 alloy designation 514.0. Exposed anodized aluminum finishes shall be as shown. Welding for aluminum products shall conform to AWS D1.2.

2.6 ANODIC COATING

****
NOTE: Edit the following requirements as necessary for the project.
****

Anodized finish shall conform to AA DAF-45 as follows:

[Clear (natural) designation AA-M10-C22-A31, Architectural Class II 0.4 mil or thicker.]

[Integral color anodized designation AA-M10-C22-A32, Architectural Class 0.4 to 0.7 mil.]

[Electrolytically deposited color-anodized designation AA-M10-C22-A34, Architectural Class II 0.4 to 0.7 mil.]

2.7 ORGANIC COATING

Organic coating shall conform to AAMA 605, with total dry film thickness not less than 1.2 mils.

2.8 FABRICATION AND MANUFACTURE

2.8.1 Factory Workmanship

Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practicable.

2.8.2 Dissimilar Materials

Where dissimilar metals are in contact, the surfaces will be protected to prevent galvanic or corrosive action.

2.9 COLOR, FINISH, AND CONTRAST

Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____]. In buildings required to be handicapped-accessible, the characters and background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast with their background - either light characters on a dark background or dark characters on a light background.

PART 3 EXECUTION

3.1 INSTALLATION

Signs shall be installed in accordance with approved manufacturer's instructions at locations shown on the drawings. Illuminated signage shall be in conformance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Signs shall be installed plumb and true at mounting heights indicated, and by method shown or specified. Required blocking shall be installed as detailed. Signs which designate permanent rooms and spaces in handicapped-accessible buildings shall be installed on the wall adjacent to the latch side of the door. Where there is no wall space to the latch side of the door, including at double leaf doors, signs shall be placed on the nearest adjacent wall. Mounting location for such signage shall be so that a person may approach within 3 inches of signage without encountering protruding objects or standing within the swing of a door. Signs on doors or other surfaces shall not be installed until finishes on such surfaces have been installed. Signs installed on glass surfaces shall be installed with matching blank back-up plates in accordance with manufacturer's instructions.

3.1.1 Anchorage

Anchorage shall be in accordance with approved manufacturer's instructions. Anchorage not otherwise specified or shown shall include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood. Exposed anchor and fastener materials shall be compatible with metal to which applied and shall have matching color and finish. Where recommended by signage manufacturer, foam tape pads may be used for anchorage. Foam tape pads shall be minimum 1/16 inch thick closed cell vinyl foam with adhesive backing. Adhesive shall be transparent, long aging, high tech formulation on two sides of the vinyl foam. Adhesive surfaces shall be protected with a 5 mil green flatstock treated with silicone. Foam pads shall be sized for the signage as per signage manufacturer's recommendations. Signs mounted to painted gypsum board surfaces shall be removable for painting maintenance. Signs mounted to lay-in ceiling grids shall be mounted with clip connections to ceiling tees.

3.1.2 Protection and Cleaning

The work shall be protected against damage during construction. Hardware and electrical equipment shall be adjusted for proper operation. Glass, frames, and other sign surfaces shall be cleaned in accordance with the manufacturer's approved instructions.

-- End of Section --

****

DEPARTMENT OF THE ARMY **CEGS-10800 (August 1998)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**
Superseding
CEGS-10800 (October 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

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SECTION 10800

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08/98

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PART 3 EXECUTION

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-- End of Section Table of Contents --

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DEPARTMENT OF THE ARMY | **CEGS-10800 (August 1998)**
U.S. ARMY CORPS OF ENGINEERS | **------------------------**
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GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 10800

TOILET ACCESSORIES
08/98

****

NOTE: This guide specification covers the requirements for toilet accessories suitable for a wide variety of applications. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for paper towel dispenser, combo towel dispenser/waste recept, and electric hand dryer. Selection or deselection or a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****

NOTE: Buildings not excluded by the Architectural and Engineering Instructions (AEI) Design Criteria will be accessible in accordance with 36 CFR, Part 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and

Facilities.

Drawings will indicate location, dimensions, elevations, schedules, details, and such other information as required to indicate the extent of the work.

Product selections shall be based on esthetic values and cost as related to project needs.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 1036	(1991) Flat Glass

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-2380	(Rev A) Dispenser, Paper Towel
CID A-A-2398	(Rev B) Curtain, Shower and Window (Metric - SI)

1.2 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation, submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Finishes; [_____]. Accessory Items; [_____].

Manufacturer's descriptive data and catalog cuts indicating materials of construction, fasteners proposed for use for each type of wall construction, mounting instructions, operation instructions, and cleaning instructions.

SD-14 Samples

Finishes; [_____]. Accessory Items; [_____].

One sample of each accessory proposed for use. Approved samples may be incorporated into the finished work, provided they are identified and their locations noted.

SD-19 Operation and Maintenance Manuals

Electric Hand Dryer; [_____].

[Four] [_____] complete copies of maintenance instructions listing routine maintenance procedures and possible breakdowns and repairs. Instructions shall include simplified wiring and control diagrams and other information necessary for unit maintenance.

1.3   DELIVERY, STORAGE, AND HANDLING

Toilet accessories shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area protected from construction damage and vandalism.

1.4   WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2   PRODUCTS

****

NOTE: To minimize the confusion of selecting the numerous options contained in the CID documents, only those accessories and finishes normally suitable for military construction were included in this guide specification. When other accessories and finishes are required to meet the needs of the project, the specifier should review the options for inclusion. Maximum use should be made of recessed accessories in areas of hard usage.

****

2.1   MANUFACTURED UNITS

Toilet accessories shall be provided where indicated in accordance with paragraph SCHEDULE. Porcelain type, tile-wall accessories are specified in Section 09310 CERAMIC TILE. Each accessory item shall be complete with the necessary mounting plates and shall be of sturdy construction with corrosion resistant surface.

2.1.1   Anchors and Fasteners

****

NOTE: Tamperproof fasteners will be specified for accessories which have exposed fasteners in areas used by neuropsychiatric patients or prisoners and where theft or vandalism would be a problem. This guide specification places the responsibility with the Contractor for providing, subject to Government approval, fasteners and anchors of the type, size and number required to adequately secure the accessory items. Specific requirements for critical or unusual applications may refer to details on the drawings, or the specifications may be expanded to include the necessary requirements.

****

Anchors and fasteners shall be capable of developing a restraining force commensurate with the strength of the accessory to be mounted and shall be suited for use with the supporting construction. Exposed fasteners shall [have oval heads] [be of tamperproof design] and shall be finished to match the accessory.

2.1.2 Finishes

Except where noted otherwise, finishes on metal shall be provided as follows:

Metal	Finish
Stainless steel	No. 4 satin finish
Carbon steel, copper alloy, and brass	Chromium plated, bright

2.2 ACCESSORY ITEMS

****

NOTE: Drawings will show location, widths and heights, and vertical height above finished floor, as required, for accessory items.

Only those accessory items to be used will be retained. Identifying abbreviation in parentheses will be retained for those items to be used and shown on the drawings. The various accessory items will generally be used in the following locations:

DCS: Public toilets and toilets in nondomiciliary type buildings in accordance with the requirements of the using service.

EHD: Public toilets and toilets in nondomiciliary type buildings upon specific written request by the using service.

FTD: Private bathrooms used by women. Private/semi-private bathrooms in guest/transient quarters. Limit to one per bathroom.

GB: Bathrooms that will be used by handicapped or people in a weakened condition, such as in hospitals. Vertical grab bars should be considered in private bathrooms where a soap and grab bar combination (SGR) accessory is not provided. Forms and lengths will be shown on the drawings.

MC: Private bathrooms where storage of personal items in the bathroom is desirable. Limit to one per bathroom.

MG: Private bathrooms where a medicine cabinet is not provided, in general-use toilets, and hand washing areas. Mirror 450 mm (18 inches) by 750 mm (30 inches) will be specified in Section 08810 GLASS AND GLAZING. Limit to not more than one per lavatory. Adjustable tilt mirror will be provided in areas to be used by wheelchair handicapped.

MM: Areas used by neuropsychiatric patients or prisoners and where vandalism would be a problem. Limit to one per toilet in single lavatory installation.

PTD: Public toilets and toilets in nondomiciliary type buildings in accordance with the requirements of the using service. Limit to not more than one per two lavatories, except one per toilet in single lavatory installation.

PTDWR: Public toilets and toilets in nondomiciliary type buildings in areas which have regularly scheduled waste removal. Limit to one per two lavatories except one per toilet in single lavatory installation.

SND: Public toilets and toilets in nondomiciliary type buildings used by women. Disposer will be mounted in the toilet compartments. Each toilet compartment shall be accessible to a disposal unit.

SNTD: Public toilets and toilets in nondomiciliary type buildings used by women. Use of recessed units will be considered for installations which are required to present an excellent appearance. Limit to one per toilet.

SC & SCR: Installations with combination bathtub and shower SCR units which include rails and curtains. One per shower-tub installation and one

per individual shower installation.

SD: Public toilets and toilets in nondomiciliary type buildings unless included with paper towel dispenser. Limit to one per lavatory.

SH: Private toilets with lavatory unless soap dispenser is specified. Limit to one per private toilet.

SMHD: Troop facilities and other areas subject to rough usage. Installation will be detailed on the drawings.

SMLD: Private bathrooms where a glass shelf or medicine cabinet is not provided.

SGR: Installations with bathtub or shower. Limit to one per bathtub or shower-tub installation and one per separate showerhead.

TB: Private bathrooms. Limit to two per bathroom. For safety purposes in wet areas consider using a horizontal grab bar in lieu of towel bar.

TSCD: Public toilets and toilets in nondomiciliary type buildings in accordance with the requirements of the using service.

TP: Private bathrooms where a shower is provided in lieu of a bathtub. Limit to one per bathroom.

TTD: All toilet areas. Limit to one per water closet.

TTH: Private bathrooms. Limit to one per lavatory.

WR: Public toilets and toilets in nondomiciliary type buildings when requested by the using service. Limit to not more than one per two paper towel dispensers. Use of recessed combination units will be considered for installations which have frequent scheduled trash removal service.
****

Accessory items shall conform to the requirements specified below.

2.2.1 Facial Tissue Dispenser (FTD)

Facial tissue dispenser shall be [surface] [recessed] mounted, Type 304 stainless steel face, [satin finish] [bright polished finish]. Face of recessed dispenser shall be secured by friction with suitable spring steel clips. Dispenser shall have a minimum capacity of [150] [200] [300] two-ply tissues.

2.2.2 Grab Bar (GB)

Grab bar shall be 18 gauge, 1-1/4 inches OD Type 304 stainless steel. Grab bar shall be form and length as indicated. [Concealed] [Exposed] mounting flange shall have mounting holes concealed. Grab bar shall have [satin finish] [peened non-slip surface]. Installed bars shall be capable of withstanding a 500 pound vertical load without coming loose from the fastenings and without obvious permanent deformation. Space between wall and grab bar shall be 1-1/2 inch.

2.2.3 Medicine Cabinet (MC)

Medicine cabinet shall be constructed with cold-rolled carbon steel sheet of not less than .03 inch thick, formed from a single sheet of steel or shall have mechanically formed spot welded or any other suitable joints. Width, height and depth of cabinet shall be in accordance with paragraph SCHEDULE.

2.2.3.1 Sliding Door Cabinet, Class 1

Sliding door cabinet assembly shall be [surface mounted vanity] [recessed cabinet] with design and lighting arrangement as indicated. Cabinet shall have a minimum of 2 shelves. The mirror shall have [a wide frame] [a narrow frame] [no frame].

2.2.3.2 Swinging Door Cabinet, Class 2

Swinging door cabinet assembly including the lighting arrangement shall be as indicated. Assembly shall be [surface] [recess] mounted. Cabinet shall be located centrally behind the door and shall contain a minimum of two shelves. Door hinges shall be stainless steel or carbon steel. Magnets used in door catches shall be permanent type. Doors shall be [with] [without] a mirror.

2.2.4 Mirrors, Glass (MG)

Glass for mirrors shall be Type I transparent flat type, Class 1-clear. Glazing Quality q1 1/4 inch thick conforming to ASTM C 1036. Glass shall be coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating shall be highly adhesive pure silver coating of a thickness which shall provide reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass, and shall be free of pinholes or other defects. Copper protective coating shall be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and shall be of proper thickness to prevent "adhesion pull" by mirror backing paint. Mirror backing paint shall consist of two coats of special scratch and abrasion-resistant paint and shall be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

2.2.5 Mirror, Metal (MM)

Metal mirror shall be bright polished stainless steel, mirror quality, 0.037 inch minimum thickness, edges turned back 1/4 inch and recess fitted with tempered hardboard backing, and theft-proof fasteners. Size shall be in accordance with paragraph SCHEDULE.

2.2.6 Mirror, Tilt (MT)

****
NOTE: Mounting height of mirror shall be shown on the drawings.
****

Tilt mirror shall be surface mounted and shall provide full visibility for persons in a wheelchair. Mirror shall have [adjustable] [fixed] tilt, extending at least 4 inches from the wall at the top and tapering to 1 inch at the bottom. Size shall be in accordance with [paragraph SCHEDULE] [the drawings] [_____]. Glass for mirrors shall conform to ASTM C 1036 and paragraph Glass Mirrors.

2.2.7 Paper Towel Dispenser (PTD)

****
NOTE: Type I and III dispensers are intended for dispensing disposable paper towels for drying the hands. Type II dispensers are intended for dispensing disposable paper towels used for cleaning, polishing, and wiping. A tumbler key lock is the standard locking mechanism for manufacturers and push button or twist-type locks are normally a specialty, extra-cost item, if available.
****

Paper towel dispenser shall conform to CID A-A-2380, Type [I] [II] [III], shall be constructed of not less than [22 gauge carbon steel] [0.269 inch Type 304 stainless steel], and shall be [surface] [recessed] mounted. Dispenser shall have a towel compartment and a [mirror door] [and] [liquid soap dispenser]. Locking mechanism shall be [tumbler key lock] [concealed tumbler key lock].

2.2.8 Combination Paper Towel Dispenser/Waste Receptacle Units (PTDWR)

Dispenser/receptacle shall be [recessed] [semi-recessed] and shall have a capacity of [400] [600] [_____] sheets of C-fold, single-fold, or quarter-fold towel. Waste receptacle shall be designed to be locked in unit and removable for service. Locking mechanism shall be tumbler key lock. Waste receptacle shall have a capacity of [12] [18] [_____] gallons. Unit shall be fabricated of not less than 0.30 inch stainless steel welded construction with all exposed surfaces having a satin finish. Waste receptacle that accepts reusable liner standard for unit manufacturer shall be provided.

2.2.9 Sanitary Napkin Disposer (SND)

Sanitary napkin disposal shall be constructed of Type 304 stainless steel with removable leak-proof receptacle for disposable liners. [Fifty] [_____] disposable liners of the type standard with the manufacturer shall be provided. Receptacle shall be retained in cabinet by tumbler lock. Disposer shall be provided with a door for inserting disposed napkins, and shall be [recessed] [partition mounted, double access] [surface mounted].

2.2.10 Sanitary Napkin and Tampon Dispenser (SNTD)

****
NOTE: Specify sanitary napkin and tampon dispensers only when they are specifically requested, in

writing, by the Using Agency.
****

Sanitary napkin and tampon dispenser shall be [surface mounted] [recessed]. Dispenser, including door shall be Type 304 stainless steel and shall dispense both napkins and tampons with a minimum capacity of 20 each. Dispensing mechanism shall be for [complimentary] [coin] operation. Coin mechanisms shall have minimum denominations of 10 cents, 25 cents, 50 cents, [_____] [free]. Doors shall be hung with a full-length corrosion-resistant steel piano hinge and secured with a tumbler lock. Keys for coin box shall be different from the door keys.

2.2.11 Shower Curtain (SC)

Shower curtain shall conform to CID A-A-2398, Style I, size to suit conditions. Curtain shall be anti-bacterial nylon/vinyl fabric. Color shall be [_____] [as shown in Section 09915 COLOR SCHEDULE].

2.2.12 Shower Curtain Rods (SCR)

Shower curtain rods shall be Type 304 stainless steel 1-1/4 inch OD by 0.049 inch minimum [straight] [bent as required] to meet installation conditions.

2.2.13 Soap Dispenser (SD)

****
NOTE: Powdered soap dispenser should be included for a shop or industrial area. Edit to meet project requirements.
****

Soap dispenser shall be [surface mounted, liquid type consisting of a vertical Type 304 stainless steel tank with holding capacity of 40 fluid ounces with a corrosion-resistant all-purpose valve that dispenses liquid soaps, lotions, detergents and antiseptic soaps.] [surface mounted, powder type constructed of stainless steel or chromium plated zinc die casting, shall contain a swap feed mechanism and an agitator designed to break up powdered soap, and shall have a minimum capacity of 32 ounces.] [lavatory mounted, liquid type consisting of a polyethylene tank with a minimum 32 fluid ounces holding capacity and a [4 inch] [6 inch] spout length.]

2.2.14 Soap Holder (SH)

Soap holder shall be [surface mounted] [recessed] Type 304 stainless steel. Separate supports shall be stainless steel.

2.2.15 Shelf, Metal, Heavy Duty (SMHD)

****
NOTE: Where rough usage is anticipated, shelf support brackets and through-bolting of accessories should be required and indicated on the project drawings.
****

Heavy duty metal shelf shall be minimum of 18 gauge stainless steel with hemmed edges. Shelves over 30 inches shall be provided with intermediate supports. Supports shall be minimum of 16 gauge, shall be welded to the shelf, and shall be spaced no more than 30 inches apart.

2.2.16 Shelf, Metal, Light Duty (SMLD)

Light duty metal shelf shall be supported between brackets or on brackets. Brackets shall prevent lateral movement of the shelf. Shelf shall be [18 inches] [24 inches] long. Shelf and brackets shall be stainless steel.

2.2.17 Soap and Grab Bar Combination, Recessed (SGR)

Soap and grab bar combination shall be recessed type and shall be Type 304 stainless steel, [bright polished finish] [satin finish].

2.2.18 Towel Bar (TB)

Towel bar shall be stainless steel with a minimum thickness of .015 inch. Bar shall be minimum 3/4 inch diameter, or 5/8 inch square. Finish shall be [bright polish] [satin].

2.2.19 Towel Pin (TP)

Towel pin shall have concealed wall fastenings, and a pin integral with or permanently fastened to wall flange. Maximum projection shall be 4 inches. Design shall be consistent with design of other accessory items. Finish shall be [bright polish] [satin].

2.2.20 Toilet Tissue Dispenser (TTD)

Toilet tissue holder shall be [Type II - surface mounted] [Type III - recess mounted] with two rolls of standard tissue [mounted horizontally] [stacked vertically]. Cabinet shall be [carbon steel, bright chromium plated finish] [stainless steel, satin finish].

2.2.21 Toilet Tissue Dispenser, Jumbo (TTDJ)

Toilet tissue dispenser shall be surface mounted with 2 rolls of jumbo tissue. Cabinet shall be fabricated of [Type 304, 18 gauge stainless steel with Type 304, 20 gauge stainless steel door] [high-impact plastic body and transparent plastic front cover]. Cover shall have key lock.

2.2.22 Toothbrush and Tumbler Holder (TTH)

Toothbrush and tumbler holder shall be stainless steel, surface mounted. Holder shall hold a minimum of four toothbrushes in a vertical position. Size of hole for securing tumbler shall be 2-1/4 plus or minus 1/8 inch in diameter.

2.2.23 Waste Receptacle (WR)

****

NOTE: Locks are typically provided on recessed and semi-recessed receptacles.

****

Waste receptacle shall be Type 304 stainless steel, designed for [recessed] [surface] mounting. Reuseable liner, of the type standard with the receptacle manufacturer, shall be provided. Capacity shall be not less than [_____] cubic feet. Receptacles with push doors and doors for access to the waste compartment shall have continuous hinges. Locking mechanism shall be [tumbler key lock] [_____].

2.2.24 Toilet Seat Cover Dispenser (TSCD)

Toilet seat cover dispensers shall be Type 304 stainless steel and shall be [recessed mounted] [surface mounted]. Dispenser shall have a minimum capacity of 500 seat covers.

2.2.25 Toilet Seat Cover/Tissue Dispenser/Waste Receptacle (TSCTDWR)

Toilet seat cover, tissue dispenser, and waste receptacle combination shall be stainless steel and shall be [partition mounted] [recessed mounted] [surface mounted]. Dispenser shall have a minimum of 500 [seat covers] [seat covers per side] and [2] [4 (2 per side)] standard tissue rolls. Waste receptacle shall have a reuseable liner of type standard with the receptacle manufacturer. Capacity of receptacle shall be [_____] cubic feet. Locking mechanism shall be [tumbler key lock] [_____].

2.2.26 Electric Hand Dryer (EHD)

****

NOTE: Consider the use of electric hand driers in public toilet areas that may not receive daily custodian care and in areas where cleanliness is an issue such as food preparation, dining facilities, and hospitals.

****

Electric hand dryer shall be wall mounted and shall be designed to operate on 110/125 volts, 60 cycle, single phase alternating current with a heating element core rating of not more than 2100 watts. Dryer housing shall be of single piece construction and shall be [white porcelain enamel] [chrome plated steel] [baked electrostatically applied epoxy] [_____].

2.2.27 Diaper Changing Station (DCS)

****

NOTE: Omit requirement for integral dispenser for sanitary liners if not required.

****

Diaper changing station shall be [recess mounted] [surface mounted] and shall be fabricated of high impact plastic with no sharp edges. Unit fold down platform shall be concave to the child's shape, equipped with nylon and velcro safety straps and engineered to withstand a minimum static load of [340 lb] [250 lb]. Unit shall have an integral dispenser for sanitary liners. Safety graphics shall be pictorial for universal use. Color shall be [_____] [as shown in Section 09915 COLOR SCHEDULE].

PART 3 EXECUTION

3.1 INSTALLATION

Toilet accessories shall be securely fastened to the supporting construction in accordance with the manufacturer's approved instructions. Accessories shall be protected from damage from the time of installation until acceptance.

3.2 CLEANING

Material shall be cleaned in accordance with manufacturer's recommendations. Alkaline or abrasive agents shall not be used. Precautions shall be taken to avoid scratching or marring of surfaces.

3.3 SCHEDULE

****
NOTE: A schedule of the accessories required will be added. Format for the schedule may be modified to suit local preference.
****

Accessories Required

Room or Space	MG	PTD	SMLD	SD	SH	TTD
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]

-- End of Section --

****
DEPARTMENT OF THE NAVY | **NFGS-11311B**
NAVAL FACILITIES | **30 September 1999**
ENGINEERING COMMAND | **------------------------------**
GUIDE SPECIFICATION | **Superseding NFGS-11311A (09/98)**
****

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09/99

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<MTA NAME=SUBFORMAT CONTENT=NEW>

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****

SECTION 11311

PARALLEL PLATE [OR VERTICAL TUBE], GRAVITY OIL-WATER SEPARATOR
09/99

****

NOTE: This guide specification covers the requirements for parallel plate, and vertical tube gravity oil-water separators to remove free oil and particulate matter from oily waste water. If influent conditions dictate treatment beyond that provided by parallel plate separators, the designer shall prepare appropriate specifications to cover the additional treatment required.

When influent conditions require treatment beyond the capability of a parallel plate, vertical tube, or API type gravity separator (e.g. presence of a mechanical or chemical oil-water emulsion), the designer shall prepare specifications to add one or more of the following unit operations to the separation system to comply with discharge criteria:

Hydrocyclone
Chemical pretreatment unit
Flocculator
Dissolved air floatation unit
Electrocoagulation unit
Filter membranes
Cartridge filters
Activated carbon absorber
Multimedia filtration
Sludge dewatering equipment

In addition, these separators are not intended as containment devices. Where applicable regulations dictate containment of accidental spills, suitable containment systems shall be designed.

****

****

NOTE: This revision "B" to NFGS-11311 amends the issue dated 30 September 1998 by revising the submittal article to comply with the agreement reached by the SPECSINTACT Tri-Agency Committee.

****

****

NOTE: The following information shall be shown on the project drawings:

1. Inlet and outlet pipe invert elevations.

2. Sampling ports integral with the influent pipe and effluent pipe, when required.

3. Accessory equipment.

****

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN PUBLIC HEALTH ASSOCIATION (APHA)

APHA SMEWW	Examination of Water and Wastewater

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME/ANSI B16.5	(1996) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1996) Carbon Structural Steel
ASTM E 165	(1996) Liquid Penetrant Examination

AMERICAN WELDING SOCIETY, INC. (AWS)

AWS D1.1	(1998) Structural Welding Code - Steel

ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA MCAWW	(1983)Chemical Analysis of Water and Wastes

FEDERAL SPECIFICATIONS (FS)

FS SS-S-210	(Rev. A Reinst) Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints

MILITARY SPECIFICATIONS (MIL)

MIL-P-24441	(Rev. B; Supp. 1) Paint, Epoxy-Polyamide
MIL-S-45180	(Rev. D) Sealing Compound, Gasket, Hydrocarbon Fluid and Water Resistant

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC SP 10 (1994) Near-White Blast Cleaning

1.2 SYSTEM DESCRIPTION

1.2.1 Applications

****
NOTE: Delete parts of paragraph which are not applicable for project with respect to liquid carrier. Identify oily wastewater source(s) such as machine and paint shops, aircraft maintenance operations, aircraft washrack and rinse (corrosion control) areas, tank farm and fuel transfer areas, runway and fire training areas, bilge and ballast water, accidental spills, and contaminated stormwater runoff.
****

****
NOTE: Pumping of influent will mechanically emulsify oil in water unless a positive displacement pump or other low emulsifying, de-rated pump is used.
****

****
NOTE: Identify site specific atmospheric conditions that would produce a corrosive environment for oil-water separator materials so that the proper protective coatings or corrosion resistant materials can be provided.
****

The separator shall remove free oil [and] [emulsified oil] [and suspended solids] from oil-in-water mixtures of [freshwater] [freshwater and seawater] [seawater] originating from [_____] operations. The influent oil-in-water mixture will [flow by gravity] [be pumped] to the unit which [will] [will not] be located in an area with a corrosive atmosphere. [The corrosive atmosphere is composed of [_____].]

1.2.2 Influent Characteristics

****
NOTE: Insert maximum design flow and wastewater characteristics which have been established by direct measurement and chemical analysis.
****

Provide oil-water separator designed for a maximum flow of [_____] gallons per minute. Operating temperatures of the influent oil-in-water mixture will range from [_____] to [_____] degrees F and ambient air temperatures will range from [_____] to [_____] degrees F. The specific [gravity] [gravities] of the [oil] [oils] at operating oil-water temperatures will range from [_____] to [_____] and the [total grease and oil] [petroleum hydrocarbon] concentration ranges from [_____] to [_____] [milligrams per liter (mg/L)] [percent by weight]. The specific gravity of the [freshwater] [freshwater and seawater] [seawater] at operating temperatures will range from [_____] to [_____]. The average specific gravity of the suspended solids is [_____]. The influent is further characterized as follows:

****
NOTE: List additional types and concentrations of detergents, anti-oxidants, solvents, acids or bases, and heavy metals that may be present in the oil-in-water mixture. If these additional items are present: chemical addition, flocculation and dissolved air flotation, or other appropriate unit operations may be needed for effective treatment of these constituents.
****

Oil-in-Water Mixture	Minimum		Maximum
Total solids	[_____]	to	[_____] mg/L
Total suspended solids	[_____]	to	[_____] mg/L
[Total grease and oil	[_____]	to	[_____] mg/L]
[Petroleum hydrocarbons	[_____]	to	[_____] mg/L]
Detergent content	[_____]	to	[_____] ppm
pH	[_____]	to	[_____]

Oil droplet size distribution:

Greater than 150 microns	[_____] percent
Greater than 100 microns	[_____] percent
Greater than 50 microns	[_____] percent
Greater than 20 microns	[_____] percent
[_____]	[_____] percent

1.2.3 Performance Requirements

****
NOTE: Make choice based on standards or guidelines established by environmental regulatory agency(ies); or other design considerations, such as unit wastewater treatment process(es) that follow downstream from this separator. Quantity of free oil removed is dependent on characteristics of oil-in-water mixture. The practical minimum concentration achievable is 10 mg/L for a parallel plate separator under ideal conditions.
****

****

NOTE: In general, free oil is defined as dispersed oil globules that rise to the surface of the water in which it is contained. The rate of rise of the oil particle is a function of its size and specific gravity as defined by Stoke's Law. Oil droplets with diameters of greater than 20 microns and specific gravities of 0.95 or less are considered to constitute the free oil form. Smaller oil droplet diameters are attributed to mechanically or chemically emulsified oil.

****

The [grease and oil] [petroleum hydrocarbon] concentration in the effluent from the oil-water separator shall not exceed the following limitations:

Contaminants	Maximum
[Total grease and oil, 30-day average	[_____] mg/L]
[Total grease and oil, daily maximum	[_____] mg/L]
[Petroleum hydrocarbon, 30-day average	[_____] mg/L]
[Petroleum hydrocarbon, daily maximum	[_____] mg/L]
[_____]	[_____]

To achieve [this goal] [these goals], it will be necessary to remove all free oil droplets equal to or greater than [_____] microns.

1.3 SUBMITTALS

****

NOTE: Where a "G" in submittal tags follows a submittal item, it indicates Government approval for that item. Add "G" in submittal tags following any added or existing submittal items deemed sufficiently critical, complex, or aesthetically significant to merit approval by the Government. Submittal items not designated with a "G" will be approved by the QC organization.

****

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Separator; G

[Accessory equipment; G]

Submit shop drawings for separator [and accessory equipment] including principal dimensions, location of fittings and unit foundation. Include data to verify center of gravity with the unit empty and filled with water.

SD-05 Design Data

Separator; G

[Accessory equipment; G]

Submit analysis, signed by a registered professional engineer, which indicates that at the calculated overflow rate, the separator will be provided with the required square feet of projected plate separation area to achieve the specified performance under laminar flow (i.e. Reynolds number of less than 500) conditions. Calculations shall take into account the rate of flow, potential surge flow, influent concentrations, particle characteristics, fluid temperature, fluid specific gravities, and pH.

SD-06 Test Reports

Shop hydrostatic test; G

Submit results of hydrostatic and dynamic testing.

Inspection

Field hydrostatic test

Preoperational test

In-service test

SD-07 Certificates

Separator corrosion protection; G

Submit written verification on the fabricator's letterhead that surface preparation and coating application were performed in accordance with the manufacturer's printed recommendations for the coating system.

SD-08 Manufacturer's Instructions

Separator system; G

SD-10 Operation and Maintenance Data

Separator system; G, Data Package 3

[Accessory equipment; G, Data Package 3]

Submit operation and maintenance data in accordance with Section 01781, "Operation and Maintenance Data."

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Inspect materials delivered to site for damage; unload and store with minimum handling. Store materials on-site in enclosures or under protective coverings. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, such as subfreezing temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover and avoid damage due to high temperatures. Do not store materials directly on ground. If special precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its crating.

1.4.2 Handling

Handle separator in such a manner as to ensure delivery to final location in sound, undamaged condition. Take special care not to damage interior and exterior surfaces of separator, coalescing plates, [or tubes] and associated supports and pipe coatings or linings. Make satisfactory repairs to damaged materials at no cost to Government. Carry and do not drag materials.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Insert reinforced concrete or other suitable material if carbon steel is not acceptable. On larger separators (e.g. flow rate greater than 50 gpm, 1/4 inch minimum thickness for carbon steel is recommended. Consult manufacturers' data.

****

Use [3/16] [_____] inch minimum thick carbon steel conforming to ASTM A 36/A 36M [_____] or material having equivalent structural properties and corrosion resistance for tank, hoppers, stationary and adjustable weirs, nozzles, flow distributor and energy dissipator device, bolts, seals, stiffeners, washers, [tank cover] and nuts. Weld in accordance with AWS D1.1 to provide watertight tank that will not warp or deform under load. Use welders qualified in accordance with AWS Standard Qualification Procedure. Grind welds smooth and remove weld spatter. Fabricate free of kinks and sharp bends in a manner not to reduce the strength of steel to a value less than that intended by the design. Size and shape of bends shall be uniform. Clean and finish [carbon steel] [_____] surfaces as described in paragraph entitled "Separator Corrosion Protection."

2.1.1 Separator Corrosion Protection

2.1.1.1 Steel Separator

After shop conducted hydrostatic tests have been successfully completed, provide a MIL-P-24441 coating system to the interior and exterior surfaces of the separator. Prior to shop painting, abrasive blast clean the surfaces in accordance with SSPC SP 10 to a surface profile of 1 to 2 1/2 mils. Apply primer conforming to MIL-P-24441/1, Formula 150 applied to a minimum dry film thickness of 3 to 4 mils. Apply intermediate coat conforming to MIL-P-24441/2, Formula 151 applied to a minimum dry film thickness of 3 to 4 mils. Apply topcoat conforming to MIL-P-24441/3, Formula 152 applied to a minimum dry film thickness of 3 to 4 mils. Total dry film thickness shall not be less than 9 mils. Repair and replace areas of the coating system which are found to be damaged or defective upon delivery of equipment to the site or found to be defective due to work of the applicator. An interior polytetrafluoroethylene liner with a minimum thickness of 1/8 inch may be provided in lieu of paint coating the interior tank surfaces.

2.1.1.2 Other Than Steel Separator

****
NOTE: If other than steel is specified for the separator material, the designer shall specify an appropriate protective coating system for the separator material specified.
****

After shop conducted hydrostatic tests and have been successfully completed, provide a coating system which will protect the separator from the oil-in-water mixture, [atmosphere,] and in situ soil conditions specified herein.

2.1.1.3 Cathodic Protection

****
NOTE: Specify cathodic protection for metal separators in contact with soil. Design cathodic protection in accordance with the current edition of MIL-HDBK-1004/10, "Electrical Engineering Cathodic Protection" and edit the appropriate guide specification for inclusion in the project specification.
****

For [below ground] [partially above and partially below ground] [above ground] metal separators, provide cathodic protection with test stations as specified in Section [13110, "Cathodic Protection by Galvanic Anodes"] [13111" "Cathodic Protection by Impressed Current"] in addition to the protective coating.

2.1.2 Substitutions

****
NOTE: Designer shall check manufacturer's literature to assure construction material option selected is capable of withstanding anticipated forces and moments for the size of separator designed. Navy has experienced some problems with the fiberglass covered plywood and timber units when the fiberglass cracks; due to water seepage, wood has deteriorated causing structural failure.
****

****
NOTE: Insert suitable material if carbon steel is not acceptable. Consult manufacturers' data.
****

Separators constructed of [reinforced fiberglass] [reinforced glass fiber resin laminates over a rigid urethane foam core] [or] [reinforced glass fiber resin laminates over plywood and timber] may be provided in lieu of carbon steel [_____]. Provide fiber glass tanks with lifting straps. Glass fiber reinforced plastic weirs may be accepted as a suitable weir and baffle material provided that necessary requirements for anchorage of these items include provisions for contraction and expansion. Surfaces shall be seamless, chemically resistant to oil-in-water mixture, and resistant to ultraviolet deterioration. Preserve wood components prior to applying resin laminates to prevent deterioration.

2.1.3 External Surfaces

****
NOTE: Include bracketed text as appropriate for below ground or partially below ground installations.
****

External tank surfaces and appurtenances shall be resistant to corrosion from the in situ soil, [backfill material,] [groundwater,] [and surface runoff] [surface runoff and the surrounding atmosphere] [soil pH] [soil resistivity].

2.1.4 Internal Surfaces

****
NOTE: The solvents in oil allow some plastic composite surfaces to absorb the oil. Once the plastic surfaces become saturated with oil they can become sticky. This is especially critical with plates since solids will tend not to slide down and eventually will clog the area between the parallel plates, resulting in increased maintenance.
****

Parallel plate [or vertical tube] material and orientation shall enhance oil coalescence and solids removal, and be corrosion and chemically resistant to the oil-in-water mixture [and atmosphere] as specified in paragraph entitled "SYSTEM DESCRIPTION."

2.1.5 Hardware

Bolts, stiffeners, washers, nuts, screws, pins, and fittings as required shall be corrosion resistant [and resistant to seawater]. Provide materials that are inherently corrosion resistant and not merely treated with a corrosion-resistant coating, such as provided by the galvanizing process.

2.1.6 Accessibility

Parts subject to wear or requiring adjustment, inspection, cleaning or repair shall be accessible and capable of convenient removal when required.

2.2 TANK

Provide [above ground] [below ground] [partially above and partially below ground] tank to withstand hydraulic and soil loadings under static and dynamic conditions while empty and during operating conditions. Provide adequate support for additional loadings from tank appurtenances including weirs, hoppers, internal supports, parallel plate [or vertical tube] oil coalescers, equipment transportation, and rapid lowering and braking of load during handling operations. Bolt tank [and accessories] to weld-fabricated, structural steel skid base, or mount on manufacturer's standard base.

2.2.1 Lifting Mechanism

****
NOTE: For units fabricated from fiberglass, specify straps. In a salt water environment substitute acceptable non-corroding metal such as but not limited to copper-nickel, 316 stainless steel, or monel. Aluminum is unacceptable. Consult manufacturers' data.
****

Fit tank with lifting [lugs] [straps] [padeyes] [supports] for handling and installation. Each [lug] [strap] [padeye] [support] shall carry the total dry weight of the tank and attendant appurtenances. Prominently display lifting instructions on [anodized aluminum] [_____] plate located on outside of tank.

2.2.2 Nozzles

Fit tank with nozzles specified.

Nozzle	Inside Diameter (Inch)	No. Required
Influent	[_____]	[_____]
[Primary Solids Outlet	[_____]	[_____]]
[Primary Oil Outlet	[_____]	[_____]]
Secondary Solids Outlet	[_____]	[_____]
Secondary Oil Outlet	[_____]	[_____]
Effluent	[_____]	[_____]
Drain	[_____]	[_____]
Vents	[_____]	[_____]

2.2.3 Flanges

Use only flat face flanges and drill 150 pound ANSI Standard bolt circle and remove burrs. Use flanged piping connections that conform to ASME/ANSI B16.5, welding neck type.

2.2.4 Weirs

****
NOTE: Insert suitable material if carbon steel is not acceptable. Consult manufacturers' data.
****

****

NOTE: Angle of slope of hopper bottom shall be greater than the angle of repose of the stored material. Volume and angle of repose for solids collected to be determined by designer based on oil-in-water mixture characteristics and frequency of cleaning.
****

Attach stationary weirs and adjustable weir supports to tank side walls to provide a watertight seal between adjoining compartments and trough to prevent hydraulic short-circuiting. Use carbon steel [_____] for weir plates and baffles. Provide sharp crested weirs of size and section specified by manufacture. Provide slotted holes in weir plates and baffles or supports to permit horizontal and vertical adjustment of weir or baffle. Use nondeteriorating sealant or gaskets for mounting weir plates. Fill voids between tank wall and weir plate with sealant to make watertight. If required, [primary and secondary hoppers] [the secondary hopper] shall have [volumes] [a volume] of [_____] [and [_____]] cubic feet. Slopes of hopper bottoms shall be [_____] degrees. Match top of [hopper] [hoppers] to bottom of tank and span entire tank width. Locate settleable solids outlet [nozzle] [nozzles] at hopper low point and at longitudinal centerline of tank.

2.2.5 Low Point Drains

Provide means at low points for dewatering tank.

2.2.6 Identification Plates

****
NOTE: In a salt water environment substitute acceptable non-corroding metal such as but not limited to copper-nickel, 316 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) to be established by designer.
****

Provide [anodized aluminum] [_____] identification and instruction plates and stamp necessary data. Securely affix plates, in prominent location, to tank with nonferrous screws or bolts of not less than 1/8 inch in diameter. Nomenclature shall be [_____].

2.2.7 Instruction Plates

Instruction plates shall describe special or required procedures to operate and service equipment, and shall include warnings of hazardous procedures and notice of safety and health requirements. Plates shall be durable and legible throughout equipment life.

2.2.8 Warning Sign

On entrances to the tank (and entrances to the vault) place a permanent sign which states the following: "DO NOT ENTER TANK (OR VAULT) OR PERFORM HOT WORK ON OR IN TANK UNTIL THE ATMOSPHERE HAS BEEN TESTED AND CERTIFIED GAS FREE AND SAFE."

2.3 INLET COMPARTMENT

****
NOTE: If total solids are less than 100 mg/L, these elements may be eliminated after adequate benchscale testing has been completed to support this conclusion. Designer shall indicate run of solids removal line from outlet nozzle to a point above grade.
****

Provide inlet compartment of sufficient volume to effectively reduce influent [suspended] [settleable] solids and dissipate energy. Provide nonclogging flow distributor and energy dissipator device [and the primary solids collection hopper as specified in paragraph entitled "Reduction of Solids"]. Locate [adjustable, primary surface oil overflow weir and] sample ports as recommended by the manufacturer.

2.4 OIL COALESCING COMPARTMENT

2.4.1 Parallel Plates

Provide parallel plates at an angle from 40 to 60 degrees with respect to longitudinal axis of the plate corrugations and space not less than 1/4 inch and not more than 3/4 inch apart for removal of free oil and settleable solids. Configuration used shall not promote solids buildup on plates which would increase velocities to point of discharging an effluent of unacceptable quality. Maintain laminar flow at maximum design flow rate throughout plate packs including entrance and exit so as to prevent re-entrainment of oil(s) with water. Flow through plate packs shall be in a downflow mode parallel to plate corrugations or cross-flow perpendicular to plate corrugations, so that the oil collects and coalesces at high point of corrugations and rises to top of pack without clogging from oil or settleable solids.

[2.4.2 Vertical Tubes

If vertical tubes are provided, install tubes perpendicular to bottom of tank and align in a pattern to maintain laminar flow at maximum design flow rate through tube packs including entrance and exit to prevent emulsifying the oil(s) with water. Inlet to tube packs shall prevent hydraulic short-circuiting of oil-in-water mixture across the top of the tubes.

]2.4.3 Supports

Brace and support individual plates [and tubes] or plate packs [and tube packs] to withstand loads associated with transportation and operation of units, including inplace cleaning. Equip each plate [or tube] pack with lifting lugs or other attachments for handling and installation. Each lug shall carry total weight of plate pack [or tube pack]. Provide adequate structural supports to facilitate inplace cleaning of plate pack [or tube] bundles.

2.4.4 Baffles

Provide oil retention baffle, adjustable surface oil overflow weir with trough, and stationary underflow baffle. Position underflow baffle to prevent resuspension of solids that have accumulated in secondary solids hopper.

2.5 OUTLET COMPARTMENT

Provide outlet compartment of [_____] cubic feet, an adjustable overflow effluent weir, a sampling port, and nozzles.

2.6 ACCESSORIES [AND ACCESSORY EQUIPMENT]

****

NOTE: Specific project requirements may include one or more of the following accessories:

Access platforms
Access ladders (with minimum 42 inch extensions above hatch opening with locking device)
Handrailing
Waste oil transfer pump
Oily waste transfer pump
Sludge transfer pump
Sludge or waste oil storage tanks
Immersion heaters
Tank windows
System monitoring and control instrumentation (e.g. oil content monitor, oil-water interface sensors, control panel, pressure gages, high level alarms, oil flooded alarms, tank level indicators)
Sight glasses
Inlet strainer (duplex)
Air vent valve
Pitot tube sampling valve assemblies
Check valves
Manually actuated valves
Motor actuated valves
Explosion proof doors
Separator backwash system

Select and specify as required. For those accessories required in the project, specify detailed requirements (including sizes, ratings, capacities, performance characteristics) in subparagraphs under paragraph entitled "ACCESSORIES [AND ACCESSORY EQUIPMENT]."

****

****

NOTE: Review applicable Federal, State, and local air pollution and ventilation requirements to determine need for vapor containment.

****

Provide bolts, stiffeners, washers, nuts, screws, pins, gaskets, and fittings as required for adjustable weirs, [tank covers] and parallel plate packs [or vertical tube packs]. [Provide tank covers with a vapor proof seal for vapor control with [_____] inch inside diameter gas vents and suitable access manways to each separator compartment.]

2.7 FABRICATION

****

NOTE: Specific project requirements may include one or more of the following accessories:

Access platforms
Access ladders (with minimum 42 inch extensions above hatch opening with locking device)
Handrailing
Waste oil transfer pump
Oily waste transfer pump
Sludge transfer pump
Sludge or waste oil storage tanks
Immersion heaters
Tank windows
System monitoring and control instrumentation (e.g. oil content monitor, oil-water interface sensors, control panel, pressure gages, high level alarms, oil flooded alarms, tank level indicators)
Sight glasses
Inlet strainer (duplex)
Air vent valve
Pitot tube sampling valve assemblies
Check valves
Manually actuated valves
Motor actuated valves
Explosion proof doors
Separator backwash system

Select and specify as required. For those accessories required in the project, specify detailed requirements (including sizes, ratings, capacities, performance characteristics) in subparagraphs under paragraph entitled "ACCESSORIES [AND ACCESSORY EQUIPMENT]."

Where the separator is to be mounted in a concrete vault with a hatch cover, the designer shall address, as a minimum, the following:

1. Hatch covers shall provide access to the entire separator.

2. Hatch covers shall lock in the open position.

3. Light weight covers for non-traffic areas.

4. Interior ladder rungs shall not be set away from cover opening so as to require a person to swing in and grab.

****

****

NOTE: Review applicable Federal, State, and local air pollution and ventilation requirements to

determine need for vapor containment.
****

Provide shop fabricated, skid mounted oil-water separator, or other shop fabricated unit approved by the Contracting Officer, which is comprised of a tank containing an inlet compartment, parallel plate [or vertical tube] oil coalescing compartment, outlet compartment [and the following accessories]:

[Tank Cover [with vapor proof seal]]
[_____]

2.7.1 Shop Hydrostatic Test

Prior to applying coatings, perform hydrostatic test at atmospheric pressure by filling tank with water in the shop for a minimum of 4 hours. Testing shall be conducted after all seams have been cleaned and all welds have been inspected in accordance with ASTM E 165. Acceptance criteria, for the hydrostatic test, is no leakage after 4 hours using a thorough visual inspection for the leaks.

2.7.2 Reduction of Solids

****
NOTE: Designer shall address special influent characteristics as part of the design when using this specification. Special characteristics include, but are not limited to, inflow rate, grit content, viscosity of petroleum product, AFFF foam, heavy metals, and reverse emulsion. Determine need for a solid waste basin preceding the separator and specify solid waste basin requirements when required by site conditions.
****

****
NOTE: If total solids are less than 100 mg/L, these elements may be eliminated after adequate benchscale testing has been completed to support this conclusion. Designer shall indicate run of solids removal line from outlet nozzle to a point above grade.
****

Inlet compartment shall reduce [suspended] [settleable] solids to nonclogging level for parallel plates [or vertical tubes,] and provide a uniform oily wastewater hydraulic loading across inlet face of oil coalescing compartment, under laminar flow conditions. Submit proof that separator will not clog given the influent characteristics. Equip compartment with an inlet nozzle with wastewater sampling port, nonclogging flow distributor and energy dissipator device, [primary solids collection hopper,] [primary solids outlet nozzle,] [oil retention weir,] [adjustable surface oil overflow weir with trough,] [primary oil outlet nozzles]. [The oil-water separator shall be preceded by a solid water basin which includes a removable solids or trash basket. Equip the solid water basin with a hoist for servicing the trash basket. Size the basket to retain all solids larger than 3 inches in any dimensions. The solid waste basin shall have a minimum storage volume of [250] [_____] gallons.]

2.7.3   Oil Coalescing Compartment

****
NOTE: The interpretation of "easily removable" has two meanings in the industry. One is the complete removal of the entire bundle from the separator; the second is removal of individual one foot square bundles. The designer shall adapt the specification to the specific demands of the project.
****

Equip oil coalescing compartment with easily removable and reinstallable, parallel, corrugated plates [, or vertical tubes] arranged to optimize separation of free oil from liquid carrier. Provide adjustable surface oil overflow weir with trough, oil outlet nozzle and stationary underflow baffle, oil retention baffle positioned to prevent discharge of free oil that has been separated from the carrier liquid in inlet and oil coalescing compartments. Provide access to each plate pack [or tube bundle] from top. Each bundle shall be equipped with handles or lifting rings. Plate designs that permit cleaning of plate packs in place are acceptable. When plate design permits cleaning in place, provide sufficient access to permit complete cleaning of the plates and removal of the sludge.

2.7.4   Wastewater Sampling Port

Equip inlet and outlet compartments, adjustable overflow effluent weir, effluent trough, and wastewater outlet nozzle with wastewater sampling ports permitting easy access for obtaining isokinetic influent and effluent samples.

2.7.5   Connections

Connect the separator at the inlet and outlet pipe invert elevations indicated. Follow equipment manufacturer's recommendation for setting and adjusting top of weir elevations throughout unit.

2.7.6   Storage

****
NOTE: In order to size the waste oil tank, the designer shall contact the activity to determine frequency of waste oil collection performed at the activity. Designer shall check current Federal and State requirements governing the need and installation criteria for secondary containment (e.g. double wall waste oil tank).
****

Provide oil and suspended solids collection, storage, and transfer systems as an integral part of proposed oil-water separator system. As a minimum, the separator oil storage (tower) compartment shall have a capacity of not less than 10 percent of the total tank volume. The adjacent waste oil tank shall have a capacity of [_____] gallons.

PART 3   EXECUTION

3.1 INSPECTION

Inspect each component of separator for compliance with requirements specified in PART 2 PRODUCTS. Redesign or modification of equipment to comply with specified requirements, or necessary redesign or modification following failure to meet specified requirements, shall receive particular attention for adequacy and suitability. This element of inspection shall encompass visual examinations and dimensional measurements.Noncompliance with specified requirements, or presence of one or more defects preventing or lessening maximum efficiency of separator operation, shall constitute cause for rejection.

3.2 INSTALLATION

Lift tank as required without parallel plate packs [or vertical tube packs] in place onto level foundation using lifting mechanism provided. Level tank and bolt to supports to prevent hydrostatic uplift and ensure unit stability. Use a lifting bar through lugs to insert plate [or tube] packs into tank and place on supports. Caulk around packs and pack supports with sealing compound conforming to FS SS-S-210 or to MIL-S-45180 to prevent hydraulic short-circuiting. Avoid abrupt contact between the packs and the tank walls and pack supports to avoid damage. Separator system installation shall be conducted in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

3.3.1 Field Hydrostatic Test

After separator has been leveled and secured to foundation and parallel plate packs [or vertical tube packs] are in place, level effluent overflow weir at elevation specified by manufacturer and hydrostatically test unit at atmospheric or operational pressure (for no leakage) for an additional 8 hours by filling with water. Perform the hydrostatic test prior to backfilling below ground or partially below ground installations.

3.3.2 Preoperational Test

The manufacturer's service representative shall inspect, operate, and test unit before in-service testing by the Contractor.

3.3.2.1 Tests

Tests shall include but not be limited to the following:

a. Soundness (without cracked or otherwise damaged parts).

b. Completeness in all details, as specified.

c. Correctness of setting, alignment, and relative arrangement of each component.

d. Verification of proper operation for all system components.

3.3.2.2 Preoperational Investigation and Test Report

Submit manufacturer's service representative's preoperational test report. Document inspections, operations, adjustments, and tests performed and indicate whether they were acceptable or not. For unacceptable items, describe corrective action taken or recommended. Include detailed descriptions of points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. Include the manufacturer's certificate that equipment conforms to specified requirements and is ready for permanent operation and that nothing in installation will render manufacturer's warranty null and void.

3.3.3 In-Service Test

After hydrostatic test and preoperational test have been successfully completed and unit has been properly connected to influent and effluent piping, allow influent oil-in-water mixture previously described in paragraph entitled "SYSTEM DESCRIPTION" to flow into separator filled with water. Adjust and level [primary] [and secondary] surface oil overflow weirs to optimize oil skimming and minimize water overflow to oil recovery. Optimize operation of unit within 5 working days. Operate unit for a minimum of ten tank volume changes prior to testing for removal of contaminants and document testing results.

3.3.3.1 Analytical Methods

Test and sample preservation methods for test contaminants shall be in accordance with the latest revisions of APHA SMEWW, APHA Standard Methods for the Examination of Water and Wastewater, EPA MCAWW, EPA Methods for Chemical Analysis of Water and Wastes, or those substitute methods approved by the governing regulatory agencies having jurisdiction.

3.3.3.2 Test for Contaminants

Verify the separator efficiency by testing influent and effluent for contaminants described in paragraph entitled "Performance Requirements." If effluent quality is found to be unacceptable, then verify influent to effluent performance in particle size removal at the site. Tests shall be performed by an independent certified testing laboratory.

3.3.3.3 Sampling Procedures

****

NOTE: The separator top hatch covers are used by many manufacturers to satisfy the sampling port requirement. The designer has the option to provide dedicated sampling points integral to the influent pipe and effluent pipe.

****

Within an 8 hour period and at regular intervals collect a minimum of 10 influent and effluent samples from sampling ports provided as part of the separator. Purge each sampling port to remove built-up solids or other material prior to collecting sample. Collect wastewater samples isokinetically in clean glass containers with polytetrafluoroethylene lined caps. Collect duplicate wastewater samples in separate glass containers. Do not attempt to split sample. Use containers for other contaminants as recommended in references listed in paragraph entitled "Analytical Methods."

3.3.3.4 Acceptance Criteria

****

NOTE: Based on standards or guidelines established

by environmental regulatory agency(ies) in which the project is located or based upon wastewater treatment process(es) that follow downstream from this separator, specify the maximum unacceptable limit permitted in order for the separator to be accepted as meeting the performance requirements of this specification.
****

90 percent of the effluent samples taken shall not exceed the specified daily maximum limit for [grease and oil] [petroleum hydrocarbon] contaminants. The remaining samples shall not exceed [[_____] mg/L for grease and oil] [[_____] mg/L for petroleum hydrocarbon] contaminants. If the separator does not meet requirements of this specification, due to poor workmanship and wrong fabrication dimensions, the unit may be rejected. If the unit is not operating at design efficiency 5 days after installation, Government may reject system. In the event Government rejects unit, Contractor shall remove separator or defective components and replace with acceptable unit or components and test as specified above.

****
NOTE: Suggestions for improvement of this specification will be welcomed using the Navy "Change Request Forms" subdirectory located in SPECSINTACT in Jobs or Masters under "Forms/Documents" directory or DD Form 1426. Suggestions should be forwarded to:

Officer In Charge
Seabee Logistics Center
NAVFAC 15G/SLC 46
4111 San Pedro Street
Port Hueneme, CA 93043-4410
FAX: (805) 985-6465/982-5196 or DSN 551-5196
****

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-12320 (May 1998)**
U.S. ARMY CORPS OF ENGINEERS | **---------------------**
Superseding
CEGS-12390 (June 1993)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes Special Change (Tailoring Options) (June 1998)
Includes changes through Notice 2 (April 1999)

Latest change indicated by CHG tags

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05/98

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****

SECTION 12320

CABINETS AND COUNTERTOPS
05/98

****

NOTE: This guide specification covers the requirements for cabinets and countertops. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for frame type cabinets, and frameless type cabinets. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****

NOTE: The type of cabinet, configuration of drawers and doors, details of shelving (fixed or adjustable) fittings, countertop type, installation fittings,

and other necessary details will be indicated on the drawings. The kitchen will be planned so that manufacturer's standard stock sizes of cabinets can be selected.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z124.3	(1995) American National Standard for Plastic Lavatories.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 570	(1995) Water Absorption of Plastics
ASTM D 638	(1997) Tensile Properties of Plastics
ASTM D 2583	(1995) Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM E 84	(1997a) Surface Burning Characteristics of Building Materials

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A156.9	(1994) Cabinet Hardware

KITCHEN CABINET MANUFACTURERS ASSOCIATION (KCMA)

KCMA ANSI/KCMA A161.1	(1995) Performance & Construction Standards for Kitchen and Vanity Cabinets

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3	(1995) High-Pressure Decorative Laminates

1.2 DESIGN

Cabinets shall be wood, factory-fabricated and finished in the manufacturer's standard sizes and finishes of the type, design, and configuration indicated. Cabinets shall be constructed as specified and shall meet the requirements of KCMA ANSI/KCMA A161.1. Wall and base cabinet assemblies shall consist of individual units joined into continuous sections. Fastenings shall be accomplished to permit removal and replacement of individual units without affecting the remainder of the installation. Counters shall be provided with watertight sink rim when indicated. Drawers shall be removable and shall be equipped with position stops to avoid accidental complete withdrawals. Shelves shall be fixed or adjustable as indicated.

1.3 SUBMITTALS

****

NOTE: Submittals, must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Cabinets and Countertops; [_____].

Manufacturer's printed data, catalog cuts, installation and cleaning instructions.

SD-04 Drawings

Cabinets and Countertops; [_____].

Drawings showing each type of cabinet and related item, and clearly indicating the complete plan, location, and elevations of the cabinets and accessories and pertinent details of construction, fabrication, and attachments.

SD-09 Reports

Cabinets and Countertops; [_____].

Test reports certifying that all cabinets comply with the requirements of KCMA ANSI/KCMA A161.1. Tests shall be conducted by independent laboratories approved by KCMA. KCMA certification seals affixed to the cabinets will be accepted in lieu of certified test reports.

SD-14 Samples

Cabinets and Countertops; [_____].

In lieu of individual samples, complete minimum size cabinets may be furnished as samples. Mock-up units are not acceptable. Samples shall be of sufficient size to show color, pattern, and method of assembly.

a. Countertop and backsplash - One section, containing both.

b. Door and drawer front - One of each, with hardware mounted.

c. Countertop color samples approximately 2 x 3 inches size.

d. Stain/color samples approximately 2 x 3 inches size.

1.4 DELIVERY AND STORAGE

Cabinets shall be delivered to the jobsite wrapped in a protective covering. Cabinets shall be stored in accordance with manufacturer's recommendations in an adequately ventilated, dry location that is free of dust, water, or other contaminants and in a manner to permit access for inspection and handling. Cabinets shall be handled carefully to prevent damage to the surfaces. Damaged items that cannot be restored to like-new condition shall be replaced.

PART 2 PRODUCTS

2.1 CABINETS

****

NOTE: Specify good grade for natural finish and sound grade for paint finish.

****

Wall and base cabinets shall be of the same construction and same outside appearance. Door design shall be [[solid flush face] [framed inset hardwood panels] [glass face]] from vendors standard styles. Corner cabinets shall be equipped with [[notched shelving] [full circle shelves]] as indicated. Shelves shall be fixed or fully adjustable as indicated. Adjustable shelves shall be capable of adjusting on approximately 3 inch increments. Shelves shall be supported by self-locking clips or wood dowels. Dowels shall be approximately 5/16 inch in diameter by 1-9/16 inches long. Dowels shall be inserted into borings for the shelf adjustments. Shelves shall be minimum 1/2 inch thick plywood or minimum 1/2 inch thick 45 pound density particle board. Drawer fronts shall be [45 pound density particle board or hardwood plywood to match cabinet door construction.] [3/4 inch thick solid hardwood frame with hardwood plywood panel.] [7/16 inch solid wood panel.] [5/8 inch thick,45 pound density particle board core.]

2.1.1 Frame Type Cabinets

The cabinets shall be constructed with frame fronts and solid ends, or frame construction throughout. Frame members shall be 3/4 inch thick by 1-1/2 inch wide; kiln-dried hardwood, glued together, and shall be either mortised and tenoned, dovetailed or doweled, nailed, stapled or screwed. Top and bottom corners shall be braced with either hardwood blocks that are glued together with water resistant glue and nailed in place, or metal or plastic corner braces. Backs of wall cabinets shall be 1/8 inch thick plywood, tempered hardboard or 3/8 inch thick,45 pound density particle board. Backs of base and tall cabinets shall be 3/8 inch thick hardwood or 3/8 inch thick, 45 pound density particle board. Bottoms of cabinets shall be minimum 3/8 inch thick plywood 45 pound density particle board or [good grade] [sound grade] plywood and shall be braced with wood members glued in place. Cabinet ends shall be [5/8 inch thick hardwood plywood] [5/8 inch thick, 45 pound density particle board core] [3/8 inch thick, 45 pound density particle board].

2.1.2 Frameless Type Cabinets

****

NOTE: Frameless cabinetry may be slightly oversized. When considering a frameless design, incorporate trimmable fillers to allow for any excess. This becomes increasingly important when the design requires cabinetry to fit snugly between two walls or other confined areas.

****

The cabinets shall be of frameless design and construction. Cabinets shall be constructed of minimum 5/8 inch thick, 45 pound density particle board end and floor panels. Cabinet back shall be constructed of minimum 3/16 inch thick, 45 pound density particle board. Hanging rails shall be doweled and glued to end panels, then fastened and hot melt glued to cabinet back. Toe kick plates shall be recessed, doweled and glued to the end panels. Top and bottom corners shall be braced with either hardwood blocks glued together with water resistant glue and nailed in place, or fastened with metal or plastic corner braces.

2.2 COUNTERTOPS AND BACKSPLASH

****

NOTE: Designer must select the type countertop material most appropriate for the project.

If a backsplash is not used, delete "AND BACKSPLASH" from the title and remove all references to backsplash from the text.

****

2.2.1 High-Pressure Laminated Plastic Clad Countertops

Clad countertop and backsplash shall be constructed of [3/4 inch thick plywood] [or] [3/4 inch thick, 45 pound density particle board core] and shall be [post formed cove type] [or] [fully formed type]. [Cove type shall be a single unit with self-edging and plastic laminate coved at the juncture of the countertop and backsplash.] [Fully formed type or square edge shall be a unit with shaped edges using wood nose molding at counter edge and shall include a separate backsplash. Backsplash shall be not less than 3-1/2 inches high.] Edging and trim shall consist of plastic laminate cut and fitted to all exposed edges. End splashes constructed of 3/4 inch plywood or 3/4 inch thick, 45 pound density particle board core shall be supplied. Continuous sheets of longest lengths practicable shall be provided. Joints in surface sheeting shall be tight and flush and held to a practicable minimum. When the countertop and backsplash are two separate units, GP50 plastic laminate shall be used. When the countertop and backsplash are one unit, PF42 plastic laminate shall be used. Plastic laminate shall conform to the requirements of NEMA LD 3 and plastic laminate adhesive shall be contact type applied to both surfaces. For fully formed and cove type countertops, the post-forming plastic laminate shall not be bent to a radius smaller than the limit recommended by the plastic manufacturer.

2.2.2 Solid Polymer Countertops

Countertop and backsplash shall be constructed [with integral [sink] [and] [lavatory]] [of sheet material for sink/lavatory cutout]; as shown. Material shall be [1/2] [3/4] [_____] inch thickness, cast, and filled nonporous solid surfacing composed of acrylic polymer, mineral fillers, and pigments. Superficial damage to a depth of 0.010 inch shall be repairable by sanding or polishing. Material shall comply with the following performance requirements.

a. Tensile Strength; 4100 psi, when tested in accordance with ASTM D 638.

b. Hardness; Barcol Impressor 50 when tested in accordance with ASTM D 2583.

c. Flammability; rated Class I with a flame spread of 25 maximum and a smoke developed of 100 maximum when tested in accordance with ASTM E 84.

d. Boiling water resistance; no effect when tested in accordance with NEMA LD 3.

e. High temperature; no effect when tested in accordance with NEMA LD 3.

f. Liquid absorption; 0.06% maximum (24 hours) when tested in accordance with ASTM D 570.

g. Sanitation; National Sanitation Foundation approval for food contact in accordance with Standard 51 and approval for food area applications.

h. Impact resistance; no failure for ball drop when tested in accordance with NEMA LD 3.

2.2.3 Solid Polyester Resin Cultured Marble Counter Tops

Countertop and backsplash shall be constructed [with integral [sink] [and] [lavatory]] [of sheet material for sink/lavatory cutout]; as shown. Material shall be [12.7] [19] [_____] mm [1/2] [3/4] [_____] inch thickness, cast, and filled nonporous solid surfacing composed of polyester resin crushed marble, glass frit, mineral fillers and pigments. Material shall comply with ANSI Z124.3 and the following performance requirement. Flammability shall comply with Class I, flame spread of 25 maximum and a smoke developed of 100 maximum when tested in accordance with ASTM E 84.

2.3 Sink/Lavatory Rims

****

NOTE: Omit this paragraph if not required by the project.

****

Sink/lavatory rims shall be of the [corrosion resistant steel clamping type, sized to the sink] [type as shown], and a standard product of a manufacturer regularly producing this type of equipment.

2.4 FINISH

2.4.1 Cabinet Finish

Cabinets shall be provided with a factory-applied durable finish in accordance with KCMA ANSI/KCMA A161.1 requirements and of a type standard with the manufacturer. Natural finish wood doors, drawer fronts, cabinet fronts, and exposed cabinet sides shall be fabricated of wood which will be free of extreme color variations within each panel or between adjacent panels. Exposed exterior surfaces shall be [hardwood or grade A-A hardwood veneer with natural stain and sprayed on factory applied finish.] [melamine plastic finish.] [paint-finished wood doors, drawer fronts, cabinet fronts, and exposed cabinet sides fabricated of hardwood or grade C hardwood veneer.] [vinyl wrap.]

2.4.2 Melamine Laminated Interior Cabinet Finish

Plywood, particle board or tempered hardboard cabinet backs shall be finished with a melamine laminate on the exposed side. Particle board shelves shall be covered on both sides with a laminated melamine finish. Melamine laminate shall conform to the requirements of NEMA LD 3 and laminate adhesive shall be contact type applied to both surfaces.

2.4.3 Backer Sheets

Backer Sheets of high pressure plastic laminate, shall conform to NEMA LD 3, Grade BK20 and shall be applied to the underside of all core material.

2.5 HARDWARE

Hardware shall conform to BHMA A156.9, shall be suitable for kitchen cabinet use, and shall include all miscellaneous hardware for a complete installation. Door hinges shall be self-closing type. Drawer runners shall have nylon rollers standard with the manufacturer. Hardware and fastenings for doors and drawers with particle board cores shall be of the through-bolt type. The types and finishes of hardware shall be as follows:

	BHMA DESIGNATION	
TYPE	NUMBER	FINISH
[_____]	[_____]	[_____]

2.6 COLOR, TEXTURE, AND PATTERN

Design, color, and finish shall be [selected from manufacturer's standard.] [as indicated.] [as specified in Section 09915 COLOR SCHEDULE.]

PART 3 EXECUTION

3.1 INSTALLATION

Cabinets shall be installed level, plumb, and true to line, and shall be attached to the walls or floors with suitable devices to securely anchor each unit. Countertops, accessories, and hardware shall be installed as indicated. Installation shall be in accordance with the manufacturer's approved printed instructions. The inner edge of sink cut-outs in laminated plastic tops shall be painted with a coat of semigloss enamel paint and sink flanges shall be set in a bed of sealant. Closer and filler strips and finish moldings shall be provided as required. Prior to final acceptance, doors shall be aligned, and hardware shall be adjusted.

3.2 CLEANING

Cabinet and countertop surfaces shall be cleaned in accordance with manufacturer's instructions.

-- End of Section --

****

DEPARTMENT OF THE ARMY | **CEGS-12350 (April 1999)**
U.S. ARMY CORPS OF ENGINEERS | **------------------------**
Superseding
CEGS-12335 (October 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

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DEPARTMENT OF THE ARMY **CEGS-12350 (April 1999)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**
Superseding
CEGS-12335 (October 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 12350

CASEWORK FOR MEDICAL AND DENTAL FACILITIES
04/99

****
NOTE: This guide specification covers the requirements for metal and wood casework for medical and dental facilities. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL: http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: This specification covers metal and wood casework, normally preassembled, for installation as fixed or built-in elements in medical and dental facilities. All casework shall be shown on the drawings. A schedule of casework shown, in alpha-numerical order, will be included on the drawings. (See paragraphs 1.2 and 6.2.1 of FS AA-C-2929). Schedules will include the Joint Schedule Number (JSN) designator, and dimensions. FS AA-C-2929 covers spacing of shelves but does not cover how many will be required per unit, therefore, the schedule or elevations should indicate the number of shelves required. Joint Schedule Numbers (JSN) or the National Stock Numbers are specified in MIL-STD-1691. Any additional specially required

casework items which are not covered by MIL-STD-1691 or FS AA-C-2929 should be described herein and identified on the drawings and schedule.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 920	(1998) Elastomeric Joint Sealants

FEDERAL SPECIFICATIONS (FS)

FS AA-C-2929	(Basic) Casework, Metal and Wood (Medical and Dental) (Inch Pound)

1.2 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Data

Casework; [_____].

Manufacturer's printed data, catalog cuts, and instructions for installation and cleaning.

SD-04 Drawings

Casework; [_____].

Drawings showing each type of cabinet and related item. The drawings shall clearly indicate the complete plan and elevations of the cabinets and accessories and pertinent details of construction, fabrication, and attachments.

SD-13 Certificates

Casework; [_____].

Certificates attesting that the casework meets the requirements specified.

SD-14 Samples

Casework; [_____].

In lieu of individual samples, complete minimum size casework may be furnished as samples. Mock-up units are not acceptable. Samples shall be of sufficient size to show color, pattern, and method of assembly.

a. Counter top and backsplash - One section, containing both.

b. Door and drawer front - One of each, with hardware mounted.

c. Melamine plastic color samples approximately 2 x 3 inch size.

d. Stain/color samples shall be approximately 2 x 3 inch size.

1.3 DELIVERY AND STORAGE

Casework shall be delivered to the jobsite wrapped in a protective covering. Casework shall be stored in an adequately ventilated, dry location that is free of dust, water, or other contaminates and in a manner to permit access for inspection and handling. Casework shall be handled carefully to prevent damage to the surfaces. Damaged items that cannot be restored to like-new condition shall be replaced.

PART 2 PRODUCTS

2.1 CASEWORK

Casework shall be as scheduled on the drawings. The casework shall be factory fabricated of manufacturer's standard sizes and finishes and shall conform to FS AA-C-2929 and the requirements specified below. Material finish and color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

2.1.1 Medical Casework

****

NOTE: Plastic laminated casework may be used in non corrosive areas such as hospital rooms and nursing stations. Corrosion resisting steel should be specified for areas, such as laboratories, where highly corrosive chemicals are handled.

****

Medical casework shall be [baked enamel carbon steel.] [corrosion resisting steel.] [wood core or carbon steel covered with laminated plastic sheets.]

2.1.2 Dental Casework

Dental operator casework shall be [wood core] [carbon steel] covered with laminated plastic sheets. Dental prosthetics casework shall be [baked enamel carbon steel.] [corrosion resisting steel.]

2.1.3 Counter tops

Counter tops shall be [corrosion-resisting steel] [plastic laminate covered plywood] [plastic laminate covered particleboard] [modified epoxy resin] [or] [resin coated laminated pressed wood fiber].

PART 3 EXECUTION

3.1 INSTALLATION

Casework shall be located as indicated. The installation of the casework shall not damage the work of other trades. The casework shall be secured in place in true alignment, level, and plumb. Units shall be secured with screws through backs to cleats that have been anchored to building structure with toggle or expansion bolts. Wall-hung cabinets shall be installed to support the weight of the cabinets plus the normally expected weight of the contents of the cabinets. Fasteners shall be spaced 12 inches on center using at least three bolts in each 3 foot or 4 foot unit width. Adjoining cabinets in an assembly shall be joined together at top and bottom with inconspicuous bolts or clips. Cabinets shall be bolted to bases at cabinet corners. Metal bases shall be faced with resilient material similar to the base provided for the space adjacent to the cabinets. Where base cabinets and counters are removable, wall anchors shall be readily accessible. Joints between the casework and wall surfaces which are not larger than the joints between casework sections shall be sealed flush with sealant conforming to ASTM C 920, Type M, Grade NS, Class 25, Use NT. Larger joints shall be closed with filler strips of the same material and finish as adjacent casework. Filler strips shall be cut to the contour of the wall surface and secured to the casework with concealed nails or screws. Width of filler strips shall not exceed 6 inches in width. Metal cabinets in rooms having terrazzo or ceramic-tile floors shall be set on concrete or masonry bases with exposed faces finished the same as other bases in the room. Height of counter tops shall be as indicated on the drawings. Where required, toe space at front of cabinets shall be provided by installing front face of cabinets 3 inches in front of face of base. Where toe space is not required, face of base and cabinets shall be flush. Bases shall have a height of approximately 4 inches. All items shall be installed as required for proper operation in accordance with the manufacturer's directions.

3.2 CLEANING

Cabinets and countertops shall be cleaned in accordance with manufacturer's instructions.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-12490 (January 1998)**
U.S. ARMY CORPS OF ENGINEERS **---------------------------**
Superseding
CEGS-12520 (December 1996)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

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01/98

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DEPARTMENT OF THE ARMY | **CEGS-12490 (January 1998)**
U.S. ARMY CORPS OF ENGINEERS | **--------------------------**
Superseding
CEGS-12520 (December 1996)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 12490

WINDOW TREATMENT
01/98

****

NOTE: This guide specification covers the requirements for window blinds, shades, curtain hardware, and curtains. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 WORK DESCRIPTION

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

FEDERAL SPECIFICATIONS (FS)

FS AA-V-00200 (Rev B) Venetian Blinds

NATIONAL FIRE PROTECTION (NFPA)

NFPA 701	(1996) Methods of Fire Tests for Flame-Resistant Textiles and Films

1.2 GENERAL

Window treatment shall be provided, complete with necessary brackets, fittings, and hardware. Each window treatment type shall be a complete unit provided in accordance with paragraph WINDOW TREATMENT PLACEMENT SCHEDULE. Equipment shall be mounted and operated as indicated. Windows to receive a treatment shall be completely covered. The Contractor shall take measurements at the building and shall be responsible for the proper fitting and hanging of the equipment.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Window Treatments and Hardware; [_____].

Manufacturer's data composed of catalog cuts, brochures, product information, and maintenance instructions.

SD-04 Drawings

Window Treatments and Hardware; [_____].

Drawings showing fabrication and installation details. Drawings shall show layout and locations of track, direction of draw, mounting heights, and details.

SD-14 Samples

Window Treatments and Hardware; [_____].

Three samples of each type and color of window treatment. Blind slats or louvers shall be 6 inches in length for each color. Track shall be 6 inches in length. Shade material shall be minimum 6 x 6 inches in size.

1.4 DELIVERY, STORAGE, AND HANDLING

Components shall be delivered to the jobsite in the manufacturer's original packaging with the brand or company name, item identification, and project reference clearly marked. Components shall be stored in a dry location that is adequately ventilated and free from dust, water, or other contaminants and shall have easy access for inspection and handling. Materials shall be stored flat in a clean dry area with temperature maintained above 50 degrees F.

1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2 PRODUCTS

2.1 WINDOW BLINDS

****

NOTE: Most manufacturers offer at extra cost a dual color combination. A dual color combination such as aluminum on top and black on the bottom can deliver maximum solar radiation protection in the summer and maximize solar radiation in the winter.

****

Each blind, including hardware, accessory items, mounting brackets and fastenings, shall be provided as a complete unit produced by one manufacturer. All parts shall be one color unless otherwise shown, and match the color of the blind slat. Steel features shall be treated for corrosion resistance.

2.1.1 Horizontal Blinds

****

NOTE: Typically horizontal blinds are fabricated to fill the openings from head-to-sill and jamb-to-jamb with inside mounted brackets. A clearance of 6 mm (1/4 inch) should be allowed at each jamb. This typical mounting procedure may not be appropriate under certain conditions for Type II slats and for windows in special frames, sliding glass doors, or windows in doors. Check specifications of glass manufacturer for recommended clearances when detailing the mounting

****

Horizontal blinds shall conform to FS AA-V-00200, [Type I (2 inch slats)] [Type II (1 inch slats)], [_____] except as modified below. Blind units shall be capable of nominally 180 degree partial tilting operation and full-height raising. Blinds shall be [inside] [outside] mount as shown.

Tapes for Type I slats shall be longitudinal reinforced vinyl plastic in 1-piece turn ladder construction.

2.1.1.1 Head Channel and Slats

Head channel shall be steel or aluminum nominal [0.018 in. for Type I] [0.024 for Type II]. Slats shall be aluminum, not less than [0.008] [0.006] inch thick, and of sufficient strength to prevent sag or bow in the finished blind. A sufficient amount of slats shall be provided to assure proper control, uniform spacing, and adequate overlap.

2.1.1.2 Controls

The slats shall be tilted by a transparent tilting wand, hung vertically by its own weight, and shall swivel for easy operation. The tilter control shall be of enclosed construction. Moving parts and mechanical drive shall be made of compatible materials which do not require lubrication during normal expected life. The tilter shall tilt the slats to any desired angle and hold them at that angle so that any vibration or movement of ladders and slats will not drive the tilter and change the angle of slats. A mechanism shall be included to prevent over tightening. The wand shall be of sufficient length to reach to within 5 feet of the floor.

2.1.1.3 Intermediate Brackets

****

NOTE: Appropriate spacings for placement of intermediate brackets at, 1200 mm (48 inches) and 1500 mm (60 inches) are typical for Type II blinds and 2100 mm (84 inches) for Type I blinds.

****

Intermediate brackets shall be provided for installation of blinds over [48] [60] [84] inches wide and shall be installed as recommended by the manufacturer.

2.1.1.4 Hold-Down Brackets

Universal type hold-down brackets for sill or jamb mount shall be provided.

2.1.2 Vertical Blinds

****

NOTE: Typically vertical blinds will be wall mounted with outside brackets, sill length. Certain instances will call for different installation methods. When selecting a ceiling mount with inside brackets, the designer should verify that the window recess will accommodate this type installation.

****

Vertical blind units shall be capable of nominally 180 degree partial tilting operation and full stackback. The blinds shall be listed by the manufacturer as designed for heavy duty strength applications including heavy duty hardware. Vertical blinds shall be [ceiling] [wall] mounted with [outside] [inside] brackets as shown. Blinds shall be [sill] [floor] length. Outside mount type installation shall provide adequate overlap to control light and privacy.

2.1.2.1 Louvers

****

NOTE: Fabric louvers are freehanging and different from groover louvers. Groovers are vinyl louvers with fabric inserts included. Edit accordingly and do not use groovers and fabric louvers together.

Generally, 88.9 mm (3-1/2 inch) blinds will be specified because they are more economical. In some cases, 50 mm (2 inch) blinds will be more aesthetically pleasing because of the window size.

Typically, a bottom chain will be provided when blinds need extra control from movement, over an air vent or operable window. Edit to fit project.

****

[Solid vinyl louvers shall be fire resistant, UV stable, impact resistant, and shall not emit corrosive fumes in a fire. Louvers shall [have a bottom chain] [hang without a bottom chain].] [Aluminum louvers shall be aluminum alloyed for maximum strength, flexibility, and resistance to internal and external corrosion. Louvers shall [have a bottom chain] [hang without a chain].] [Fabric louvers shall be inherently flame retardant. The louvers shall have straight, flat, unfrayed edges and shall be flat, without noticeable twists. A weight shall be provided at the bottom of the louver. The insert shall not discolor the fabric. Louvers shall [have a bottom chain] [not have a bottom chain].] [Groovers shall be extruded from solid vinyl with clear non-yellowing channel lips to accept fabric inserts. Fabric inserts shall be flame retardant and colorfast.] [3-1/2 inch louvers shall overlap not less than 3/8 inch] [2 inch louvers shall overlap not less than 1/4 inch] and shall be dimensionally stable.

2.1.2.2 Carriers

Carriers shall be provided to support each louver. Carriers shall be of molded plastic and shall transverse on self-fabricated wheels for smooth, easy operation. The hook of the carrier shall have an automatic latch to permit easy installation and removing of the louver, and shall securely lock the louver for tilting and traversing.

2.1.2.3 Headrail System

Headrail system shall be not less than 0.047 inch thickness and shall be made of anodized aluminum alloy or 0.027 inch thick phosphate treated steel with a baked on ivory gloss enamel paint finish. The headrail shall extend the full width of the blind and each end shall be closed with an end cap. One cap shall contain the traversing and tilting controls. The opposite cap shall house the pulley for the traversing cord.

2.1.2.4 Cornice, Fascia, or Valance

****

NOTE: A cornice, fascia, or valance will normally be provided if cost permits. When the color is an accent color other than the blind color it should be referenced in paragraph COLOR or on the drawings.

****

Manufacturers standard [cornice] [fascia] [valance] shall be attached to the headrail by metal or plastic holders which grip the top and bottom edge of the valance and shall [accept an insert of the same material as the slats] [_____]. There shall be sufficient clearance behind the valance to permit the louvers to tilt without interference. The headrail cover shall extend the full width of the blind. Returns shall be formed of a single piece where the end of the head is visible.

2.1.2.5 Controls

****

NOTE: Typically a tilting control baton is used because it is unobtrusive. Control mechanisms generally are on the right side, but window placement may require the controls to be placed on the left side for ease of operation.

Select which direction the vertical blind will traverse, considering there must be adequate space for the width of the stack without concealing any electrical or mechanical components. Sliding glass doors shall have a one way draw with stackback occurring opposite door openings.

****

Tilting control and traversing controls shall hang compactly at the [right] [left] side of the blinds and shall reach within 5 feet of the floor. The [tilt/traverse control baton] [bead chain tilting control] shall tilt all vanes simultaneously to any desired angle and hold them at that angle. The louvers shall traverse [one way to the right] [one way to the left] [two-way split]. [The traversing control cord shall be minimum 0.070 inch in diameter with a minimum breaking strength of 125 pounds. The cord shall be anchored to a lead carrier which shall be linked to all adjacent carriers. The louvers shall be traversed along the headrail by pulling one side of the looped cord. A weighted pulley shall be provided at the bottom of the cord.] [or] [A fiberglass wand shall tilt the louvers by turning the wand and shall traverse the louvers by using the wand as a drapery baton.]

2.1.2.6 Connectors and Spacers

The connector shall be flexible, smooth and flat to slide unhindered when carriers move independently of each other, and to nest compactly when carriers are stacking. The length of the links shall relate to the louver width in order to equally space the traversing louvers, to maintain uniform and adequate overlap of louvers, and to fully cover the width of the opening.

2.1.2.7 Intermediate Brackets

Intermediate installation brackets shall be furnished for blinds over 62 inches wide.

2.2 WINDOW SHADES

****

NOTE: Light filtering shades are translucent and

softly diffuse light to the amount that the fabric selected by the designer allows. Room darkening (black-out) shades are opaque and block out light completely. The designer should specify a complete room darkening system only if total light block is necessary, as in an audio visual application. A room darkening shade is typically made of a vinyl coated fiberglass cloth. Do not specify cotton cambric fabric for room darkening shades since it cannot provide total light block. Coordinate maximum unit sizes available with the window sizes.
****

Roller tube shall operate smoothly and be of sufficient diameter and thickness to prevent excessive deflection. Brackets shall be provided that are appropriate for [inside] [outside] [ceiling] mount. The shade cloth shall meet the performance described in NFPA 701, small scale test. Steel features shall be treated for corrosion resistance.

2.2.1 Light Filtering Shades

Light filtering shades shall conform to the following: Roller tube shall be [wood] [steel] and shall operate by [spring] [clutch and bead operation] mechanism. Fascia mounting brackets shall be steel to support roller tube and fascia panel. The fascia panel shall be channel shaped extruded aluminum with standard enamel finish. The shade shall be made from a single piece of [pvc coated fiberglass cloth] [_____].

2.2.2 Room Darkening Shades

Room darkening (black-out) window shades shall conform to the following: Roller tube shall be aluminum and shall be controlled by [webbing tape] [crank operated gear box with steel rods]. Light traps shall be shop fabricated, and shall consist of a head box to house the shade roller, and U-shaped channels to serve as guides for the shade along the sides and to receive the bottom edge of the shade along the sill. Light trap shall be made of sheet steel having a minimum thickness of 22 gaugeor anodized, extruded, aluminum. The legs of the channels shall be not less than 1-3/4 inches long and separated by the minimum distance that will permit free operation of the shade. Edges of light trap coming into contact with the shade cloth shall be smooth pile light seal. The exposed face of the head box shall be hinged or removable for access to the shade roller. The interior or unexposed surfaces of the light trap shall have a finish coat of flat black enamel. The exposed portions of the light trap shall have a factory-applied [priming coat of gray paint. Finish painting is specified in Section 09900 PAINTING, GENERAL.] [anodized bronze or clear finish as shown.] Shade roller shall be manufacturer's standard product. Cloth shall be of type for blackout purposes. The shade shall be made from a single piece of [canvas duck cloth laminated to vinyl] [_____]. When not finished with a selvage, the vertical edges of the shade shall be bound or hemmed using a high-grade thread. Needle holes shall be made lightproof by applying a suitable filler. The bottom edge of the shade shall be fitted with a steel operating bar. Shades will engage positively with bottom rail through operating bar or chain pull. Bars shall be painted with flat black enamel. Pull cords shall be made of No. 4 braided nylon or beaded chain having not less than 175 pounds breaking strength.

2.3 COLOR

Color shall be [in accordance with Section 09915 COLOR SCHEDULE] [_____].

PART 3 EXECUTION

3.1 WINDOW TREATMENT PLACEMENT SCHEDULE

****

NOTE: The Window Treatment Placement Schedule will be provided at the designer's option when it will clarify placement of the treatments. For example, when all areas do not receive a window treatment or when interior windows receive a window treatment, the use of this schedule would be appropriate. When all exterior windows are to receive a window treatment, a note can be made to this effect instead of filling out the schedule completely. The location should be clearly defined within this specification. The Placement Schedule will be completely filled out with the room number and name, window type, draw type, and direction.

****

Window covering shall be provided as follows:

Room Number/Name	Window Covering Type	Drapery Draw Type/Direction	Window Type
[_____]	[_____]	[_____]	[_____]

3.2 INSTALLATION

Installation shall be in accordance with the approved detail drawings and manufacturer's installation instructions. Units shall be level, plumb, secure, and at proper height and location relative to window units. The Contractor shall furnish and install supplementary or miscellaneous items in total, including clips, brackets, or anchorages incidental to or necessary for a sound, secure, and complete installation. Installation shall not be initiated until completion of room painting and finishing operations. Upon completion of the installation, window treatments shall be adjusted for form and appearance, shall be in proper operating condition, and shall be free from damage or blemishes. Damaged units shall be repaired or replaced by the Contractor as directed by the Contracting Officer.

-- End of Section --

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DEPARTMENT OF THE ARMY — **CEGS-12705 (October 1997)**
U.S. ARMY CORPS OF ENGINEERS — **------------------------**
Superseding
CEGS-12640 (June 1993)

GUIDE SPECIFICATION FOR CONSTRUCTION

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PART 3 EXECUTION

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SECTION 12705

PREWIRED WORKSTATIONS
10/97

****

NOTE: This guide specification covers the requirements for open office systems prewired workstations. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

****

NOTE: Various provisions of this guide specification may be irrelevant to or in conflict with the requirements of any given project. The guide should be carefully tailored to fit the needs of each specific application. Portions must be deleted if not applicable and additional material inserted where necessary to adequately delineate requirements. Brackets and blanks identify provisions which involve alternates; the editor must select and/or insert the appropriate requirements.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in

project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(1984; R 1994) Safety Glazing Materials Used in Buildings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 423	(1990a) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C 1048	(1992) Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials
ASTM E 290	(1992) Semi-Guided Bend Test for Ductility of Metallic Materials

BUSINESS AND INSTITUTIONAL FURNITURE MANUFACTURERS ASSOCIATION (BIFMA)

BIFMA ANSI/BIFMA X5.5	(1989) Desk Products - Tests
BIFMA ANSI/BIFMA X5.6	(1993) Panel Systems - Tests

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA SP 2950	(1996) Commercial Building Standard for Telecommunications Pathways and Spaces

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WD 1	(1983; R 1989) General Requirements for Wiring Devices
NEMA WD 6	(1988) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code
NFPA 101	(1997) Life Safety Code
NFPA 255	(1996) Method of Test of Surface Burning Characteristics of Building Materials

UNDERWRITERS LABORATORIES (UL)

UL 723	(1996) Test for Surface Burning Characteristics of Building Materials
UL 1286	(1993; Rev thru Jul 1996) Office Furnishings

1.2 GENERAL

This specification establishes the minimum requirements for the acquisition and installation of a complete and usable system of workstations composed of panels, supporting components, electrical hardware, [communications,] [special electrical features,] and accessories. Workstation requirements and configurations shall be in accordance with the furniture layout and typical workstation types shown in drawings and specified herein. Components, and hardware shall be provided by a single manufacturer and shall be a standard product as shown in the most recent published price lists or amendments. Electrical components shall be products of a single manufacturer to the extent practicable (different types of components may be of different manufacturers, but all units of a given component shall be from a single source). The completed installation shall comply with NFPA 70 and NFPA 101 as shown. The Contractor shall coordinate the work of this section with that to be performed under other sections. This specification may include requirements which are not manufactured by the furniture manufacturer; any such requirements shall be furnished by the Contractor under this section.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

SD-14: Task lights may be omitted from the list of samples in small projects (under 20 lights total).

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Manufacturer's Product Data; GA.

Manufacturer's product and construction specifications which provide technical data for prewired workstation panels and components specified, including task lighting and illumination performance information. Literature shall include adequate information to verify that the proposed product meets the specification.

SD-04 Drawings

Prewired Workstations; GA.

Drawings showing the proposed prewired workstation installation at a scale of 1/4 inch = 1 foot, unless otherwise specified. Drawings showing communications, electronic data processing (EDP) and local area network (LAN) locations may be provided as a separate submittal from remaining workstation drawings. Drawing requirements which are the prewired furniture manufacturer's responsibility shall be provided as a single submittal.

a. Overall reference drawings: Drawings showing workstation locations and overall plan view within each floor. The scale shall be [1/16 inch = 1 foot][1/8 inch = 1 foot.] Layouts shall reflect field verified conditions.

b. Installation drawings: Drawings showing workstations, panels, components, and plan view within each floor. Workstations shall be identified by workstation type. Scale of drawings shall be identical to Architectural plans. Installation drawings shall reflect field verified conditions.

c. Workstation elevations: Dimensioned workstation elevations showing each type of workstation with all components identified with manufacturer's catalog numbers. Elevations shall be drawn at 1/2 inch = 1 foot scale.

d. Panel drawings: Panel drawings showing panel locations and critical dimensions from finished face of walls, columns, panels, including clearances and aisle widths. Panels shall be keyed to a legend which shall include width, height, finishes and fabrics (if different selections exist within a project), power or nonpower, panel connectors and wall mount hardware. Panel drawings shall reflect field verified conditions.

e. Panel electrical power drawings: Drawings showing power provisions including type and location of feeder components (service entry poles, base or ceiling feeds), activated outlets and other electrical components. Wiring configuration (circuiting, switching, internal and external connections) shall be identified and a legend provided as applicable.

f. Wire management capacity drawings.

g. Panel communication drawings showing telephone provisions: Drawings indicating the type and location of feeder components and outlets with wiring configuration identified where applicable.

h. Panel communication drawings showing electronic data processing provisions: Drawings indicating the type and location of feeder components, outlets, or accessories with wiring configuration identified where applicable.

i. Panel communication drawings showing local area network provisions: Drawings indicating the type and location of feeder components and data outlets with extra ports for future expansion with wiring configuration identified where applicable.

j. Reflected ceiling plan for projects specified with power poles.

SD-07 Schedules

Parts List; FIO.

One complete listing of part/model numbers for all components to be furnished, including names and codes of components referenced on drawings.

SD-08 Statements

Qualifications; FIO.

One statement indicating that the manufacturer has specialized in commercial prewired workstation manufacturing for the past 5 years.

SD-09 Reports

Selected Components; GA. Panel Acoustics; GA. Fire Safety; GA. Electrical System; GA.

One complete set of test reports for the proposed system.

SD-13 Certificates

Certificate of Compliance; FIO.

Two complete sets of certificates attesting that the proposed prewired workstation meets specified requirements. The certificate shall be dated after the award of contract, shall name the project, and shall list specific requirements being certified.

Warranty; GA.

Two copies of the warranty.

SD-14 Samples

Prewired Workstations; GA.

Four sets of the following samples. The Government reserves the right to reject any samples that do not satisfy the construction or color requirements. The Contractor shall submit additional samples as required to obtain final approval. Work shall not proceed without sample approval in writing from the Contracting Officer.

a. Panel, [tackboard] [and flipper door] fabric. Minimum 6 x 6 inches having labels on the back designating the manufacturer, color, fiber content, fabric weight, fire rating, and use (panel and/or tackboard).

b. Work surface panel, and component finish. Minimum 2-1/2 x 3 inches having labels on the back designating the manufacturer, material composition, thickness, color, and finish.

c. Screens:

d. Task lights.

e. Panel glazing. Glazing samples having labels designating the material and safety ratings.

SD-19 Operation and Maintenance Manuals

Product Assembly Manual; FIO.

Three sets of assembly manuals describing assembly and reconfiguration procedures.

Product Maintenance Manuals; FIO.

Three sets of maintenance manuals describing proper cleaning and minor repair procedures.

Electrical Systems Manual; FIO.

Three sets of electrical system manuals describing the functions, configuration, and maintenance of the electrical system (power [, communications] [, data]). This material may be included in the above 2 manuals at the Contractor's option.

1.4 QUALIFICATIONS

The manufacturer shall be a company specializing in the production of prewired workstations for a minimum of 5 years.

1.5 DELIVERY, STORAGE, AND HANDLING

Components shall be delivered to the jobsite in the manufacturer's original packaging with the brand, item identification, and project reference clearly marked thereon. Components shall be stored in a dry location that is adequately ventilated and free from dirt and dust, water, and other contaminants, and in a manner that permits easy access for inspection and handling.

1.6 PATTERN AND COLOR

****

NOTE: Include a reference to COLOR SCHEDULE or drawings for all items requiring a finish color. This includes the following items when applicable: Work Surface Colors, Pedestals and Drawers, Panel Supported Storage, Panel Trim and Connectors, Screens, Accessories, and a pattern and color reference for Panel, Flipper Door and Tackboard Fabric or customer's own material.

****

Pattern and color of finishes and fabrics for panels, components, and trim shall be [in accordance with Section 09915 COLOR SCHEDULE] [as shown on the drawings].

1.7 ALTERNATE DESIGN

****

NOTE: Minor differences exist among different manufacturer's product. This paragraph pertaining to an "alternate design" was written in order not to exclude a manufacturer when an equally acceptable solution is proposed. List minimum requirements if applicable to the project. Examples of minimum project requirements might include; minimum linear footage of overhead storage, limitation of number of panel widths, and non-handed components.
****

Manufacturers who are unable to provide workstations that conform exactly to the furniture layouts and typical workstation types shown in the contract drawings may submit alternate designs for consideration by the Contracting Officer. Alternate designs must meet or exceed the following criteria. Alternate designs that are submitted but do not meet this criteria will be rejected.

1.7.1 Workstation Size and Configuration

The alternate design shall provide workstations and components of the same basic size and configuration shown with only the sizes of the individual components within the workstation changed to meet the standard product of the manufacturer.

1.7.2 Component Requirements

The types of components or elements utilized shall be as shown on the drawings.

1.7.3 Layout

The storage capacity, number of workstations accommodated, width of isles, or workstation layout shall not be reduced.

1.7.4 Panel Wiring Configuration

Alternate configurations must support the circuiting and connection capabilities identified under the provisions pertaining to powered panels of paragraph ELECTRICAL. Generally any alternate will be acceptable which involves only a variation in size or quantity that exceeds the specified configuration.

1.8 WARRANTY

The Contractor shall warrant the prewired workstation components for a period of 10 years with the following exceptions: fabrics and other covering materials, and paper handling products shall be guaranteed for 1 year, and task lights shall be warranted for 2 years. [Electromagnetic ballasts shall be warranted for 2 years.] [Electronic ballasts shall be warranted for 3 years.] [The electronic ballast warranty shall include a $10 labor allowance for each ballast.] Warranties shall be signed by the authorized representative of the manufacturer. Warranties accompanied by document authenticating the signer as an authorized representative of the guarantor, shall be presented to the Contracting Officer upon the completion of the project. The Contractor shall guarantee that the workstation products and installation are free from any defects in material and workmanship from the data of delivery.

PART 2   PRODUCTS

****

NOTE: The designer should be certain that the combination of products specified are not proprietary and that they can be provided by several manufacturers. The prewired workstation layout shall conform to NFPA 101, and for buildings not excluded by the AEI Design Criteria shall be accessible in accordance with 36 CFR 1191.

****

2.1   PERFORMANCE AND SAFETY REQUIREMENTS

Panels, connection system, work surfaces, pedestals, shelf units, flipper door units, lateral files, locks, accessories, and miscellaneous hardware shall meet testing as specified. With the exception of ANSI, testing shall be performed by an independent testing laboratory. ANSI testing may be completed in a manufacturer's in-house testing laboratory. Component specific requirements are listed in appropriate paragraphs.

2.1.1   Selected Components

Prewired workstations shall conform to the requirements of BIFMA ANSI/BIFMA X5.5 and BIFMA ANSI/BIFMA X5.6 with the following exceptions: Panels and panel supported components shall be tested in accordance with the requirements of BIFMA ANSI/BIFMA X5.6 and representative items shall be selected for testing based on worst case situations (i.e., the deepest and widest work surface or shelf). The keyboard drawer or shelf test shall be performed applying a 50 lb load to the center of the keyboard shelf for a period of 5 minutes. Any loosening of attachments, permanent deflection or damage to the operation of the drawer or shelf will be cause for rejection.

2.1.2   Panel Acoustics

****

NOTE: Acoustical panels will not be used when panel-hung storage units cover more than half the panel surface. In these situations the acoustical advantage is lost and the stronger non-acoustical unit is cheaper.

Acoustical performance ratings should be based upon the workstation design. While NRC and STC ratings contribute to overall acoustical performance, the acoustical role of panels is relatively minimal in the overall environment when compared to sound absorptive properties of other finish surfaces. In addition, panel hung components greatly reduce the quantity of acoustical contributing area. Most major manufacturers do not comply with the higher 0.80 NRC and 24 STC without providing their more costly high performance panels. The designer must determine if the additional acoustical performance is worth the added cost to the Government. Designer must coordinate NRC and STC requirements for panel

heights above 1200 mm (48 inches). If non-acoustical panels are utilized, the entire paragraph should be deleted.
****

Acoustical panels shall have a minimum noise reduction coefficient (NRC) of [0.65] [0.80] [_____] when tested in accordance with ASTM C 423 and a minimum sound transfer coefficient (STC) of [14] [20] [24] [_____] when tested in accordance with ASTM E 290. The test shall be conducted on the entire assembled panel, full face area (the complete core, adhesive, decorative fabric, frame and joining components).

2.1.3 Fire Safety

****
NOTE: Select flame spread and smoke development in accordance with MIL-HDBK 1008B. Verify that flame spread and smoke development ratings can be met with fabric specified.
****

Components shall meet requirements for flame spread and smoke development as specified by NFPA 101 except as follows. Testing shall have been conducted in accordance with either ASTM E 84, UL 723, or NFPA 255 on the entire assembled panel and each different combination of fabric and interior construction. Panel flame spread shall not exceed [[25 for Class A] [75 for Class B] [200 for Class C]] and panel smoke development shall not exceed [[50 for Class A] [100 for Class B] [200 for Class C]].

2.1.4 General Safety

Prewired workstation products shall be free of rough or sharp edges. Panel components shall have a positive, integral locking device which secures components to the support panels without the use of additional screws or clamps so that the components cannot be accidentally pulled or knocked off the panels.

2.1.5 Electrical System

Task lights shall be UL approved and shall meet the requirements of NFPA 70. The panel electrical system shall meet the requirements of UL 1286.

2.1.6 Panel Glazing

****
NOTE: Curved glazed panels should not be specified since most products utilize an acrylic glazing. Acrylic glazing is not acceptable since it does not meet flame spread and smoke development requirements.
****

Tempered glass shall conform to ASTM C 1048, Kind FT, Condition A, Type I, [Class 1 Transparent] [Class 3 - Light reducing, tinted].

2.2 PANEL SYSTEM

Accessories and appurtenances for a completely finished panel assembly shall be supplied complete with the system. The system shall be capable of structurally supporting cantilevered work surfaces, shelves, files, and other components in the configurations shown on the drawings. The panel system shall be capable of structurally supporting more than 1 fully loaded component per panel per side. Panels shall be either tackable or capable of accommodating fabric covered tackboards. The panel system shall be available in a variety of nominal widths and heights as designated on the drawings and shall be vertically stackable. Panel height shall not exceed 80 inches plus or minus 2 inches. Heights shall be measured from the finished floor to the top of the panel. Powered and nonpowered panels shall be compatible in height. Minimum panel thickness shall be 1-1/2 inches.

2.2.1 Finishes

****

NOTE: Specify a finish and fabric for applicable items utilized. Where fabric is utilized provide fabric content. (Example: 50% Nylon, 50% Wool). The designer shall verify that fabric content, pattern, and color specified is not proprietary and that several manufacturers can provide a similar product to that specified.

Filler trim incurs added cost and should be omitted unless it is desired for aesthetic reasons.

****

The panels shall be available in the following options: [acoustical,] [non-acoustical,] [safety glazed,] [open frame]. Exposed panel trim shall have a [factory baked enamel or epoxy powder] [wood,] finish. [Filler trim shall either match the panel trim or be fabric covered to match the panel fabric.] [Filler trim shall not be provided.] Each fabric-faced panel shall have a seamless width of fabric stretched over the entire face of the panel and the color of each fabric utilized shall be consistent throughout the installation. Curved panels may use adhesives on curved sections. The fabric shall be attached securely and continuously along the entire perimeter of the panel and shall allow for easy removal and replacement in the field (with the exception of curved panels). Fabric shall be factory installed and panel fabric content shall be [_____].

2.2.2 Raceways

Raceways shall be an integral part of the panel. Panels, whether powered or nonpowered, shall be provided with a raceway cover. Magnet held base covers will not be accepted.

2.2.3 Leveling Glides

The system shall provide precise alignment of adjacent panels and shall include leveling glides to compensate for uneven floors. On panel-to-panel products, each panel shall have 2 leveling glides. On panel-to-post products each connector shall contain a leveling glide. A minimum 3/4 inch adjustment range is required for both panel-to-panel and panel-to-post systems.

2.2.4 Panel Connection System

****

NOTE: Delete connection of 2 panels for setting the panels at any angle if not required. This connection limits sources.
****

The panel system shall have connectors which accommodate a variety of panel configurations as shown on the drawings. A straight line connection of 2 panels (180 degrees), corner connection of 2 panels (90 degrees), T connection of 3 panels (90 degrees), cross connection of 4 panels (all 90 degrees), and a connection of 2 panels for setting the panels at any angle. The panel connector system shall provide tight connections with continuous visual and acoustical seals. The connector system shall allow removal of a single panel within a typical workstation configuration, without requiring disassembly of the workstation or removal of adjacent panels. The connector system shall provide for connection of panels of similar or dissimilar heights. Right angle (90 degree) connections between panels shall not interfere with the capability to hang work surfaces and other components on any adjacent panel. The connector system shall provide, as required, for the continuation of electrical and communications wiring within workstations and from workstation to workstation. Filler posts shall be level with the panel top rail.

2.2.5 Wall Mounted Panels

Panel system wall-mount accessories shall be used when it is necessary to attach panels to the building walls. Wall panels shall have structural support as required.

2.2.6 Glazed Panels

Glazed panel inserts shall be comprised of tempered glass in accordance with ANSI Z97.1. Acrylic glazing will not be accepted.

2.2.7 Door Panels

Door panels shall have a rigid metal frame with rails, a threshold, and a [wood] [laminate] clad door adaptable to either hand swing. Door panels shall be of a dimension that will allow for a 32 inch clear opening. Door panels shall include connectors, hinges, and [brushed chrome] [epoxy powder] [baked enamel] finished door knob.

2.3 WORKSURFACES

Worksurfaces shall be constructed to prevent warpage. Worksurfaces shall be either fully supported from the panels or supported jointly by the panels and supplemental legs, pedestals, or furniture end panels. Supplemental end supports shall be used only under work surfaces when the work station configuration does not permit full support by the panels. Metal support brackets shall be used to support worksurfaces from the panels, provide metal-to-metal fitting to the vertical uprights of the panels, shall be vertically adjustable, and shall lock the worksurfaces in place without panel modifications. Abutting worksurfaces shall mate closely and be at equal heights when used in side-by-side configurations in order to provide a continuous and level worksurface. Worksurfaces shall either have pre-drilled holes to accommodate storage components, pedestals and additional supports, or holes shall be able to be drilled at the job site to accommodate these items. Worksurfaces shall be provided in sizes and configurations shown on the drawings. Worksurfaces shall be available in nominal depths of [20 inches,] [and] [24 inches,] [and] [30 inches,] plus or minus 2 inches, nominal lengths from 24 to 72 inches, and a nominal thickness from 1 inch to 1-3/4 inches. Worksurfaces shall be height adjustable in 1 to 1 1/2 inch increments from 25 inches to 41 inches above the finished floor. Worksurfaces abutting at equal heights shall provide a continuous and level worksurface. [Corner worksurfaces,] [peninsula worksurfaces,] [and] [counter/transaction worksurfaces] shall be provided as shown on the drawings and shall include hardware necessary to provide firm and rigid support.

2.3.1 Finishes

The worksurfaces shall have a finished top surface of [high pressure plastic laminate], [veneer] and shall have a smoothly finished underside. The worksurface shall not be affected by ordinary household solvents, acids, alcohols, or salt solutions, and shall be capable of being cleaned with ordinary household cleaning solutions. Metal support brackets shall match the color and finish of panel trim. Edges shall be [post formed or vinyl molding] [solid wood].

2.4 PEDESTALS

Drawer configurations and pedestal height shall be as shown on the drawings. The deepest possible pedestal shall be provided for each worksurface size specified.

2.4.1 Construction

With the exception of drawer fronts, pedestals and drawers shall be of steel construction. Drawer faces shall be securely attached to the drawer front. Pedestals shall be attached to the worksurface.

2.4.2 Finishes

The finish of steel surfaces shall be a factory baked enamel finish. Drawer fronts shall be [either steel, plastic laminate, or molded plastic] [veneer].

2.4.3 Drawer Requirements

****

NOTE: Delete reference to 380 mm (15 inch) high EDP drawers if not required.

****

Pedestals shall be field interchangeable from left to right, or right to left, and shall retain the pedestal locking system capability. Pedestals shall be designed to protect wires from being damaged by drawer operation. Pedestals shall be worksurface hung, or shall support work surfaces, or shall be free standing; as shown. Drawers shall stay securely closed when in the closed position and each drawer shall contain a safety catch to prevent accidental removal when fully open. File drawers shall have either a cradle type or full extension ball bearing suspension with hanging folder frames or compressor dividers. File drawers shall be 12 inch high. Box drawers shall be provided with [pencil trays] [and] [stationary trays]. All EDP file drawers shall be 15 inch high and shall accommodate EDP printout sheets. Center pencil drawer shall be mounted under the worksurface and shall contain a removable pencil tray.

2.5 PANEL SUPPORTED STORAGE

[Flipper door cabinets,] [shelf units] [and] [lateral files] shall be provided in the sizes and configurations shown on the drawings. [Flipper door] [and] [shelf unit] cabinets shall accommodate task lighting and shall have a [depth to accommodate a standard three ring binder] [and] [minimum 15 inch depth to accommodate computer printouts].

2.5.1 Shelf Unit Construction

The shelf pan shall be of metal construction with formed edges. Shelf supporting end panels shall be constructed of metal, high density particle board, molded phenolic resin, or molded melamine. Shelf units shall accommodate relocatable shelf dividers.

2.5.2 Flipper Door Unit Construction

Flipper door unit shall be of equal construction to shelf units. Flipper doors shall be constructed of metal with formed edges, wood frame or particle board. Units shall remain securely fastened to the panel when in the locked position. Doors shall utilize a suspension system.

2.5.3 Lateral File Unit Construction

Panel hung lateral file bins shall be of steel construction. File fronts, top and end panels shall be of equal construction to flipper door units. File drawers shall have full extension ball bearing drawer slides or rack and pinion suspension. File drawers shall have hanging folder frames, compressor dividers or rails and shall be capable of hanging side-to-side or front-to-back.

2.5.4 Finish

****

NOTE: Designer should not remove an option for a factory baked enamel flipper door from this paragraph since a limited number of manufacturers offer a fabric flipper door. If fabric flipper doors are not desired for maintenance reasons, the fabric option may be eliminated since a metal flipper door is readily available. Delete wood veneer references if not required.

****

Shelves and dividers and top dust cover shall have a factory baked enamel finish. Shelf supporting end panels shall have either a factory baked enamel or laminate finish. Shelf bottom shall match end panel color. Metal doors shall have an exterior finish of factory baked enamel or a factory installed fabric covering and an interior finish of factory baked enamel. Metal drawers shall have a factory baked enamel finish. Fabric content of flipper doors shall be [_____]. [Flipper doors] [and lateral files] shall have a wood veneer surface.

2.6 ACCESSORIES

2.6.1 Coat Storage

[One panel mounted coat hook per workstation occupant shall be provided at each workstation] [and] [a panel mounted storage unit shall be provided as indicated on the drawings].

2.6.2 Keyboard Tray

****
NOTE: Delete reference to wrist supports if not required.
****

Work surfaces shall be capable of accepting [an articulating keyboard] [a keyboard shelf] on workstations as shown on the drawings. The keyboard tray shall have the capability to be fully recessed under the work surface and extend to give the user full access to the keyboard. Side travel rotation shall be a 180-degree swing. The keyboard tray shall have tilting capability and shall contain a wrist support.

2.6.3 Computer Turntables

Turntables shall be provided on workstations as shown on the drawings. Turntables shall contain a stop mechanism to prevent tangled cords.

2.6.4 Tackboards

Fabric shall be factory installed and fabric content of tackboards shall be [_____]. Location and size shall be as shown on the drawings.

2.6.5 Erasable Marker Boards

Marker boards shall have a white writing surface which can be easily written on and erased and shall be unaffected by common marker board cleaning/conditioning agents and shall contain a storage tray. Size and location shall be as shown on the drawings.

2.6.6 Paper Management Unit

Paper management units shall be provided as indicated on the drawings. These units shall be constructed of coated steel or injection molded plastic and shall accommodate either legal or letter size lengths. Unit shall not be freestanding and shall be provided as shown on the drawings.

2.6.7 Wall Mounted Components

Wall tracks shall be utilized when components are shown attached directly to wall surfaces. Tracks shall be of heavy duty extruded metal. Finish and color of tracks shall match the panel trim. Vertically aligned tracks shall be slotted on 1 inch centers in heights required. Slot spacing shall match slot spacing for wall panels.

2.7 MISCELLANEOUS HARDWARE

Brackets, supports, hangers, clips, panel supported legs, connectors, adjustable feet, cover plates, stabilizers, and other miscellaneous hardware shall be provided.

2.8 LOCKS AND KEYING

****
NOTE: The quantity of different key operations required is dependent on the size of the project.

The number specified should not exceed the quantity of workstations. The maximum quantity utilized shall not exceed 150.
****

Drawers, flipper door cabinets, and lateral files shall have keyed locks, unless otherwise noted. Field changeable lock cylinders shall be provided with a minimum of [100] [_____] different key options. Each workstation shall be individually keyed and locks within a workstation shall be keyed alike. Drawers within a pedestal shall be lockable either by a central lock that controls all pedestals under one work surface or an individual keyed lock in each pedestal. Central file and storage units which are grouped together but are not a part of a workstation shall be keyed alike unless otherwise specified. Door panels shall have keyed [door knob] [_____] set. Two keys shall be provided for each lock or 2 keys per workstation when keyed alike, and 3 master keys shall be provided per area as shown on the contract drawings. Keys and lock cylinders shall be numbered for ease of replacement. Locks shall be clearly labeled with a key number, except for those manufacturers who have removal format locks.

2.9 ELECTRICAL

****
NOTE: It is recommended that the type of cabling assembly (wiring, harnesses, or buses) be left as a Contractor selection unless necessary to restrict for compatibility with existing equipment.
****

Both powered and nonpowered panels shall have base raceways capable of distributing power circuits, [communication cables] [and] [data lines]. Nonpowered panel bases shall be capable of easy field conversion to powered panel base without requiring the panel to be dismantled or removed from the workstation. The system shall use copper [cable assemblies,] [wiring harnesses] [or] [electrified bus] and shall meet requirements of UL 1286 and NFPA 70, Article 605. Conductors shall consist of 20 amp [90] [75] degree C, #12 AWG wires or the equivalent in the bus configuration. The label or listing of Underwriter's Laboratories, Inc. will be accepted as evidence that the material or equipment conforms to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency shall be submitted indicating that the items have been tested in accordance with required procedures of UL and that the materials and equipment comply with contract requirements. Electrical work not addressed in this section shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR.

2.9.1 Panel Bases (Raceways)

****
NOTE: Raceways are available in various locations, such as, desk height and top-of-panel. Revise to meet project requirements.

When specifying desk height raceways the overhead storage unit requirements will be carefully coordinated. Desk height raceways tend to structurally weaken the panel system thereby

limiting the size or capacity of the overhead units.
****

Panels shall have hinged or removable covers which permit easy access to the raceway when required but which are securely mounted and cannot be accidentally dislodged under normal conditions. The raceway shall not extend past either panel face by more than 1/2 inch. Metal or plastic covers which attach securely to the raceway shall be provided as required and shall match the finish and color of the panel trim. Raceways in full size over 24 inches powered panels shall have a minimum of 2 knockouts (doors) per side for electrical connections or outlets as indicated elsewhere.

2.9.2   Powered Panels

****
NOTE: The 8-wire system should be utilized for applications serving mixed loads including electronic data processing equipment. Since EDP equipment generates high levels of harmonics (* see footnote below), a full size neutral should be provided for each EDP circuit. Alternately, it is recommended that the phase conductor not be loaded to more than 12A or that an oversized neutral be specified. To minimize interference from electronic noise to sensitive data processing components, the EDP equipment should be placed on the dedicated circuits. In the absence of other criteria, use of an isolated ground conductor is not recommended for the EDP circuits (See IEEE Std. 1100). If the amount of EDP load is extensive and the conventional load is minimal, a modified 8-wire system should be provided. The preferred configuration would be 3 phases, 3 neutrals, an EDP ground, and a conventional ground. Non-EDP load should be connected to one phase, one neutral, and the conventional ground. The other two phases and neutrals and EDP ground should be dedicated for EDP type loads. As a second choice the 8 wires could be designated as follows: 3 dedicated phase, 1 dedicated oversize neutral (#10 with 14 Amp maximum phase loading), and isolated ground, a conventional phase, neutral, and ground conductor. The non-EDP load should be placed on the conventional conductors. (An 8-wire configuration with 3 phases, 3 neutrals, an isolated ground, and a conventional ground could also be used. Non-EDP load should be connected to the conventional ground and least loaded phase conductor.) The 5-wire system may be used if no EDP loads are to be supplied. The 6-wire system is a less reliable, hybrid configuration in which EDP and non-EDP loads use a shared neutral. It could also be used for Air Force shared ground applications with the isolated ground connector either disconnected or interconnected with the

equipment ground.

Non-linear loads such as computers, copiers, laser printers, electronic lighting ballasts, and uninterruptible power supplies cause harmonic distortion on power distribution systems. The majority of pre-wired workstation loads are non-linear, harmonic producing loads. Designers must ensure that the building power distribution equipment can support these non-linear loads. IEEE Std 519 and 1100 provide details concerning the causes, effects, and means of compensation for non-linear, harmonic producing loads on power systems. Harmonic compensation may include, but is not limited to: specifying K-rated transformers, derating transformers, oversizing neutrals to 200% of the ampacity of the phase conductors or phase bus, using phase conductors and terminals with higher ampacities and/or higher temperature ratings, supplying non-linear loads from dedicated isolation transformers, and installing shunt filters. See CEGS-16415 for further guidance.

Surge suppression and power conditioning receptacle modules are available. However power conditioning for specific loads (particularly portable equipment) is normally a User responsibility and is not furnished as part of the construction contract. The Air Force has identified specific responsibilities of the user and suppliers of end-use equipment. (See Air Force ETL 89-6 for specific criteria or verify specific requirements for electrical support.)

****

Powered panels shall be provided as indicated on the drawings. The panels shall have an internal [power] [and] [communications] raceway and the capability of disconnecting and connecting external circuits to the electrified raceway in the panel. The communications receiving raceway shall have capacity for at least [six] [twelve] [twenty] 4-pair category 5 cables. Power and communications wiring may share a common wireway if a metal divider is included to ensure electrical isolation. Doors or access openings shall be included for entry of communications cable. The electrified power raceway shall be of the [8-wire] [6-wire] [or] [5-wire] configuration indicated. [Unless otherwise indicated, conductors of the 8-wire system shall be allocated as follows: [3 phase, a neutral, an equipment ground, and 1 each dedicated phase, [neutral] [oversized (133% minimum) neutral], and isolated ground] [1 each phase, neutral, and equipment ground, 2 each dedicated phase and neutral, 1 dedicated isolated ground].] [Conductors of the 5-wire system shall be allocated as follows: 3 phase, a neutral, and an equipment ground]. [Conductors of the 6-wire system shall be allocated as follows: 2 phase, an equipment ground, an oversized (173% minimum) neutral, a dedicated phase, and an isolated ground.]

2.9.2.1 Receptacles

Power receptacles shall be provided in the powered panels. Devices shall be placed at the locations indicated on the plans and shall be connected to the designated circuits. Unless otherwise indicated, receptacles shall be 15 amp (NEMA 5-15R) commercial grade conforming to NEMA WD 1 and NEMA WD 6. If receptacles are not interchangeable or will not permit field adjustment of phase and circuit selection, 10 percent spare devices of each type shown on these plans shall be furnished. [All] [General use] receptacles shall be of the duplex configuration; unless otherwise indicated, special use receptacles shall be of the simplex configuration with the blade/pin arrangement identified on the plans. The color of receptacle bodies shall be coordinated with the color of the panel trim. Isolated ground receptacles shall have distinct markings or be of a different color than other receptacles (orange preferred). Field applied identification shall be permanent; stick-on or non-setting adhesives shall not be used. A minimum of [5] [_____] receptacle removal tools shall be provided for systems that require special tools for proper receptacle removal.

2.9.2.2   Power Cabling Variations

The paragraph Powered Panels has identified specific cabling configurations. Since universal conventions have not been established, variant configurations available from various manufacturers will be considered. Alternates shall allow the same circuiting, device connections, neutral and ground separation, and upstream feeder connections as shown on the plans. Variations shall be approved in advance. See paragraph ALTERNATE DESIGN. Examples of acceptable variations include:

a. Use of 1 oversized neutral in lieu of 2 or 3 specified neutrals (neutral must have 150 percent minimum of phase conductor ampacity, i.e. #10 TW neutral if replacing 2 #12 TW conductors; 173 percent and #8 if replacing 3 neutrals) or vice versa.

b. Providing a 6-wire system in lieu of a 5-wire system shown on plans.

c. Use of a manufacturer's configuration which allocates individual conductors differently, but which has the same quantity of conductors and allows devices to be physically connected in the field as shown on the plans. It is not necessary that the manufacturers labeling codes or terminology match the designations used on project plans or in the specifications; however, neutrals and grounds shall have insulation color coded per standard practice or be provided with tags, colored tape, colored ribbons or similar identification. (The reference to "dedicated" conductors in this specification pertains to circuit connections upstream and load connections downstream of prewired panels; it is not necessary that manufacturer's designations correspond.)

2.9.3   Electrical Connections

****

NOTE: The direct wired configurations should be suitable for most applications. All wiring should be contained within raceways or wireways. The exposed cord/plug arrangement should not be used, unless specifically requested by the User. If used, ensure that the design conforms to the limitations of Article 605-8 of NFPA 70. Code-enforcing personnel in some areas require separate hard wired

junction box interfaces from building services to prewired workstation installations. If the facility will be under their jurisdiction, the design must conform and the junction box configuration must be provided in lieu of the direct wired. If the facility will not be under local jurisdiction, the direct wired configuration could be provided per User request; however, it is preferred that the Government design be consistent with local practice. If top entry service poles are used for power interfacing, the junction box configuration is preferred for all locations.
****

2.9.3.1 Internal Connections

Internal panel-to-panel power connections shall utilize straight or flexible plug/receptacle connector assemblies and shall be installed to provide the powered panel configurations shown on the drawings.

2.9.3.2 Connections to Building Services

External [power] [and] [communications] services shall be supplied to the panels via [direct-wired [top] [base] entry modules.] [hard wired [top] [base] entry junction box assemblies.] [Wiring from building services shall be extended to the entry modules or panel bases in metal conduit or tubing or in flexible liquidtight conduit 6 foot maximum.] [Wiring from building services shall be extended to junction box assemblies in metal conduit or tubing. Wiring from junction boxes shall be flexible liquidtight conduit 6 foot maximum or in metal conduit or tubing.] Cord and plug assemblies shall not be used for any portion of external links. [Base feed modules shall plug into the end or either side of the raceway at receptacle doors.] [Top entry [modules] [junction box assemblies] shall extend the [power] [and] [communications] wiring into service entry poles attached to the electrified panels.] External wiring shall conform to Section 16415 ELECTRICAL WORK, INTERIOR.

2.9.4 Wire Management

Wire management capability shall be provided at all workstations. Actual wire management capacity shall accommodate all cable types specified, including the applicable manufacturer required bending radius at corners. Raceways and interfaces to the raceways in the panels shall be designed to accommodate the bend radius as shown in EIA SP 2950 for Category 5 communication wiring. The capability may be accomplished by cable access cutouts (1 minimum per work surface), covered wire management troughs in vertical end panels, horizontal wiring troughs, internal midpanel raceways, or rear gaps (between the back edge of the work surface and the facing support panel). Grommet kits or another suitable finish arrangement shall be provided for all cable cutouts. Accessories for an externally mounted vertical and horizontal wire management and concealment system shall be provided [as indicated on the contract drawings] [as recommended by the manufacturer]. Horizontal wire managers shall be supplied for mounting under all work surfaces. The wire managers shall be attached either to the underside of the work surface or to the vertical panel without damage to the face of the vertical panel. Exposed or loose wiring will not be acceptable. Wire managers shall be prefinished and shall secure, conceal, and accommodate outlet cords as well as electrical and communications wiring. Wire channels shall match color of panel trim, attach to panel or rail by means of clip-on attachment, and shall conceal wires routed vertically. Power wiring shall be separated from communication wiring by use of separate raceways or by placement of channels in joint use troughs or wireways.

2.9.5   Circuit Layout

The circuit layout for workstations shall be as shown on the drawings. Devices shall be connected to the designated circuits in the neutral and ground configurations indicated. Connections shall be made to the building electrical distribution system as shown on the contract drawings and in accordance with Section 16415 ELECTRICAL WORK, INTERIOR.

2.9.6   Service Entry Poles

****

NOTE: Coordinate requirements with paragraph Powered Panels.

****

Service poles shall be provided as indicated on the contract drawings and shall be capable of minimally accommodating the [8-wire] [6-wire] [5-wire] power configuration described in paragraph Powered Panels and the equivalent of [six] [twelve] [twenty] 4-pair category 5 cables. Poles shall have metal barriers or channels to separate power and communications wiring. Pole dimensions shall be allowed to be equal to maximum panel thickness. The pole finish and color shall [match the finish and color of the panel trim] [conform to requirements shown on the plans]. Designated poles shall have the capability of being opened along the vertical access to permit the lay-in of wiring. Each pole shall have a wiring interface, an end cap and a ceiling trim plate which extends a minimum of 40 mm (1-1/2 inches) from all sides of the pole. Poles for power service shall include a junction box either as part of the pole assembly or in a field installed configuration. Service poles shall be securely attached to the panels and shall be installed plumb. Wiring and interface components shall be provided as required to connect the building power supply to power poles.

2.9.7   Task Lighting

Task light size and placement shall be provided as indicated on the contract drawings. Such lights shall be a standard component of the manufacturer's prewired workstation products. Task lights mounted to the underside of overhead shelving shall be the same length as the overhead storage unit unless otherwise indicated. The ends of the task light length shall not extend beyond the edges of the overhead unit. Task lights shall have structurally sound mounting devices which will prevent accidental displacement, but will allow easy removal and replacement when necessary. Fixtures shall be UL approved for use in the configurations indicated on the drawings.

2.9.7.1   Luminaire Configuration

****

NOTE: The lamp and ballast types should be indicated on the drawings. Use of electronic ballasts and T8 lamps is encouraged as a means of meeting energy conversation goals for the building.

Although there are no national standards for electronic ballasts, technical requirements are covered in CEGS-16415 Electrical Work, Interior. Electronic ballasts are the most efficient fluorescent ballasts, eliminate visual flicker and are quiet. When used, the electrical design must consider the harmonics and electromagnetic energy generated by these ballasts. Specific areas which should not have electronic ballasts are medical electronic equipment areas and areas equipped with infrared remote control or security devices. It is important to inform Users of the benefits and risks of electronic ballasts and to involve them in the decision regarding their use.
****

Luminaires shall be the fluorescent type and shall have prismatic lenses, baffles, or reflector systems configured to minimize glare by shielding the lamp from the view of a seated user. Task lights for each workstation shall provide a minimum of [75 foot candles] [60 foot candles] of light (horizontally measured), without veiling reflections, on the work surface directly below and a maximum of 20 inches from the fixture. All diffusers, grilles or other coverings shall be easily removable to permit cleaning and relamping. Fixtures shall be provided with energy efficient ballasts and lamps as indicated. If the type is not identified on the plans, F32T8 lamps in 4 foot units with electronic ballasts shall be used. Each luminaire shall have an easily accessible on-off switch and one rapid-start ballast. A variable intensity control is acceptable if the low setting is equivalent to "off" with zero energy consumption. Multiple switching is also acceptable. Ganged fixtures or shared ballasts shall not be used. Lamps and ballasts shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR.

2.9.7.2 Wiring

****
NOTE: If the facility will be under the jurisdiction of a city code, verify requirements. Some locations require hard wired connections.
****

Each fixture shall have a 6 foot minimum, factory installed, heavy duty electrical cordset with a grounded plug. Direct or hard wire connections are not acceptable. Unless otherwise indicated, cords shall be concealed. Provisions shall be built-in within panels or shall utilize field installed, manufacturer approved accessories. Cords may be extended through dedicated channels located at any point within panels or may be placed in vertical slots or in the space between panels if held in place by retainers and concealed by a cover plate. Vertical wire managers shall be prefinished and cut to size and shall extend from the task light level down to the top of the work surface below the task light. Each manager shall be attached to a panel vertical edge or connector strip without damage to the panel surfaces.

2.9.8 Communications

Communications wiring shall be extended to, and installed in, the electrified panels as shown on the plans. Communications outlets shall be installed at designated locations. Communications work may be performed in conjunction with the installation of the prewired workstations or may be separately executed at the Contractor's option; however, equipment, materials, and installation shall conform to the requirements of [Section 16415 ELECTRICAL WORK, INTERIOR] [Section 16710 PREMISES DISTRIBUTION SYSTEM] [_____] and all interfaces must be properly coordinated.

2.9.9   Special Systems

****

NOTE: Include this paragraph only in projects where requirements for shielded facilities (TEMPEST, Red/Black, EMP, etc.) and secure wiring have been called out in project criteria. Specific requirements for cable arrangement, separation of Red/Black lines, etc., need to be verified for each project. Provide metal raceway, channels, etc. throughout. Separation distances required for exposed cable or wiring in nonmetallic raceways are much greater than for wiring installed in totally enclosed metal raceway. Site specific details and/or notes should be prepared for each project.

****

Designated raceway systems shall provide management for secure and nonsecure power, computer and telecommunications cabling. Secure distribution shall be separated from nonsecure distribution [in accordance with details shown on the plans] [by running secure lines along top located raceway and nonsecure along the bottom of the workstation panel].

PART 3   EXECUTION

3.1   INSTALLATION

The prewired workstations shall be installed by certified installers in accordance with manufacturer's recommended installation instructions. Workstation components shall be installed level, plumb, square, and with proper alignment with adjoining furniture. The components shall be securely interconnected and securely attached to the building where required. Three sets of special tools and equipment necessary for the relocation of panels and other components shall be furnished.

3.2   CLEANING

Upon completion of installation, all products shall be cleaned and polished and the area shall be left in a clean and neat condition. Any defects in material and installation shall be repaired, and damaged products that cannot be satisfactorily repaired shall be replaced.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-13080 (April 1999)**
U.S. ARMY CORPS OF ENGINEERS **-----------------------**
Superseding
CEGS-13080 (July 1995)

GUIDE SPECIFICATION FOR CONSTRUCTION

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 13080

SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT
04/99

****
NOTE: This guide specification covers the requirements for seismic structural elements for protection of mechanical, electrical and miscellaneous equipment. This guide specification will be used in conjunction with Sections 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT and 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: The intent of this specification is to provide for adequate resistance to lateral forces induced by earthquakes for listed mechanical, electrical and miscellaneous equipment and systems. The design seismic lateral forces are in addition to the "normal" gravity forces (weight) acting on the components of a system.

Seismic protection will no longer be based on the guidance provided in TM 5-809-10 which includes

seismic zone, importance factors, and building categories. Seismic protection design for anchorage and bracing of all equipment will be based on TI 809-04. The designer will ensure that the A-E and/or Contractor has access to TI 809-04.

The designer has 3 options to provide seismic protection for a project:

1) Hire an A-E who will use this section and will submit calculations and drawings stamped by a registered engineer. The Contracting Officer will "accept" the design but the registered engineer (Engineer of Record) will have final responsibility for the adequacy of the structural members and their connections.

2) Issue a contract requiring the Contractor to hire a registered engineer to submit the stamped calculations and drawings in accordance with this section. The contracting Officer will "accept" the design but the registered engineer (Engineer of Record) will have final responsibility for the adequacy of the structural members and their connections.

3) Perform the design in house, in which case the Government designer will have final responsibility for the adequacy of the structural members and their connections.

Regardless of who performs the design, this section, properly edited, must be included in the construction documents to allow the Contractor to install the seismic protection features.

This section can be used for bracing details of medical equipment by editing the specification accordingly.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 53	(1997) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 153/A 153M	(1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 325M	(1993) High-Strength Bolts for Structural Steel Joints (Metric)
ASTM A 500	(1996) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 563	(1996) Carbon and Alloy Steel Nuts
ASTM A 572/A 572M	(1997) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 603	(1994) Zinc-Coated Steel Structural Wire Rope
ASTM A 653/A 653M	(1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM E 488	(1996) Strength of Anchors in Concrete and Masonry Elements

ASME INTERNATIONAL(ASME)

ASME B18.2.1	(1996) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(1987; R 1993) Square and Hex Nuts (Inch Series)

COE TECHNICAL INSTRUCTIONS (TI)

TI 809-04	(1998) Seismic Design for Buildings

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

****

NOTE: Designer should verify that specified details do not interfere with the performance of the cathodic protection system (when used) or of the vibration isolation systems.

For systems and equipment in buildings that have a performance objective higher than life-safety, the designer should show a "GA" classification for the items under SD-04 Drawings in the SUBMITTALS paragraph. This will allow the Engineer of Record (EOR) to: 1)Do a QC review on the anchorage and bracing details of these essential systems, and 2)Asses the impact of the bracing and anchorage details on the structural supporting system of the essential building.

Design done by the Contractor must be in accordance with TI 809-04. Loadings determined using TI 809-04 are based on strength design; therefore, the AISC LRFD specifications should be used to design the steel members in the bracing and anchorage systems.

****

The requirements for seismic protection measures described in this section shall be applied to the mechanical equipment and systems outlined in Section 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT, the electrical equipment and systems outlined in Section 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT, and the miscellaneous equipment and systems listed below. Seismic protection requirements shall be in accordance with TI 809-04 and additional data furnished by the Contracting Officer, and shall be provided in addition to any other requirements called for in other sections of these specifications. The design for seismic protection shall be based on a Seismic Use Group [I] [II] [IIIH] [IIIE] building occupancy and on site response coefficients for S_{MS} = [_____] and S_{M1} = [_____]. Resistance to lateral forces induced by earthquakes shall be accomplished without consideration of friction resulting from gravity loads. The basic force formulas, for Ground Motions A and B in Chapter 3 of TI 809-04, use the design spectral response acceleration parameters for the performance objective of the building, not for equipment in the building; therefore, corresponding adjustments to the formulas shall be required.

1.2.2   Miscellaneous Equipment and Systems

****

NOTE: The designer must ensure that the list below includes all miscellaneous items to be braced. Delete the items which are not part of the project and add items which are not included in the list. For equipment and systems in buildings with a performance objective greater than life-safety, the designer should provide two separate lists of equipment and systems; 1) Items that are essential to the higher level of post-earthquake performance, and 2) Items that are not essential but are necessary to provide a life-safety level of earthquake protection.

****

The bracing for the following miscellaneous equipment and systems shall be developed by the [A-E] [Contractor] in accordance with the requirements of this specification:

Storage cabinets	Ornamentations
Storage Racks	Signs and Billboards
Shelving	Furnishings
Partitions	[_____]

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Bracing; GA. Equipment Requirements; GA.

Copies of the design calculations with the detail drawings. Calculations shall be stamped by a registered engineer and shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

SD-04 Drawings

Bracing; [_____]. Resilient Vibration Isolation Devices; [_____]. Equipment Requirements; [_____].

Detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction. For equipment and systems in buildings that have a performance objective higher than life-safety, the drawings shall be stamped by the registered engineer who stamps the calculations required above.

1.4 EQUIPMENT REQUIREMENTS

1.4.1 Rigidly Mounted Equipment

****

NOTE: Rigidly mounted equipment is defined as having a period of vibration of 0.06 seconds or less

for the equipment plus its mounting. Equipment with a fundamental period greater than 0.06 seconds should be assumed to be flexibly mounted or nonrigid. The designer may allow a reduction to the design seismic forces applied to ground-mounted equipment when properly justified in the calculations. List items that may require additional reinforcements (internally) to prevent permanent deformation, dislocations, separation of components, or other damage, which would render the equipment inoperative for significant periods of time following an earthquake and to meet the specified requirements. Coordinate with note in paragraph BRACING.
****

The following specific items of equipment: [_____] to be furnished under this contract shall be constructed and assembled to withstand the seismic forces specified in TI 809-04, Chapter 10. For any rigid equipment which is rigidly attached on both sides of a building expansion joint, flexible joints for piping, electrical conduit, etc., that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions, shall be provided.

1.4.2 Nonrigid or Flexibly-Mounted Equipment

****
NOTE: The appropriate lateral force coefficient for nonrigid or flexibly-mounted equipment, should be calculated and inserted in the blank space.
****

The following specific items of equipment to be furnished: [_____] shall be constructed and assembled to resist a horizontal lateral force of [_____] times the operating weight of the equipment at the vertical center of gravity of the equipment.

PART 2 PRODUCTS

****
NOTE: Appropriate materials for structural supports must be used in corrosive environments. Dissimilar metals must be isolated.
****

2.1 BOLTS AND NUTS

Squarehead and hexhead bolts, and heavy hexagon nuts, ASME B18.2.1, ASME B18.2.2, or [ASTM A 307 for bolts and ASTM A 563 for nuts] [ASTM A 325 for bolts and nuts]. Bolts and nuts used underground and/or exposed to weather shall be galvanized in accordance with ASTM A 153/A 153M.

2.2 SWAY BRACING

****
NOTE: Designer should determine an appropriate specification for steel angles used for sway bracing

depending on availability of the materials from local suppliers and insert the designation in blank space below.
****

Material used for members listed [in this section] [and] [on the drawings], shall be structural steel conforming with the following:

a. Plates, rods, and rolled shapes, [ASTM A 36/A 36M] [ASTM A 572/A 572M, Grade 503]. If the Contractor does the design, both ASTM A 36/A 36Mand ASTM A 572/A 572M, grade 503 will be allowed.

b. Wire rope, ASTM A 603.

c. Tubes, ASTM A 500, Grade [B] [_____].

d. Pipes, ASTM A 53, Type [E] or [S], Grade B.

e. Light gauge angles, less than 1/4 inch thickness, [ASTM A 653/A 653M] [_____].

PART 3 EXECUTION

3.1 BRACING

****
NOTE: Designs must include complete seismic details showing bracing requirements. The design is for the supports of the equipment, not the equipment itself. Bracing does not guarantee that the equipment is rugged enough to survive earthquake shaking. When a piece of equipment is required to remain operational after an earthquake, the manufacturer should be consulted regarding the capabilities of the equipment to withstand seismic loading.
****

Bracing shall conform to the arrangements shown. Trapeze-type hanger shall be secured with not less than two 1/2 inch bolts.

3.2 BUILDING DRIFT

****
NOTE: The designer will be guided by the results of the seismic analysis to determine the expected drift of the building; this information is needed for the pipe joint designs required in Section 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT.
****

Sway braces for a piping run shall not be attached to two dissimilar structural elements of a building that may respond differentially during an earthquake unless a flexible joint is provided.

3.3 ANCHOR BOLTS

3.3.1   Cast-In-Place

****

NOTE: The designer will ensure that foundations and anchor bolts for pad-mounted or floor-mounted equipment are detailed and designed in accordance with TI 809-04. When the designer has the necessary size, weight, and other information for a piece of equipment, the anchorage details including sizes, length and number of bolts, thickness and reinforcing of pads and foundations for that piece of equipment will be shown by the designer on the drawings. When this information is not available, it will be the A-E responsibility to design the support and anchorage for the equipment in accordance with the specified requirements.

If the calculated seismic forces would cause the equipment to uplift, the anchor bolts should be designed for combined shear and tension.

****

Floor or pad mounted equipment shall use cast-in-place anchor bolts, except as specified below. [One nut] [Two nuts] shall be provided on each bolt. Anchor bolts shall conform to ASTM A 307. Anchor bolts shall have an embedded straight length equal to at least 12 times nominal diameter of the bolt. Anchor bolts that exceed the normal depth of equipment foundation piers or pads shall either extend into concrete floor or the foundation shall be increased in depth to accommodate bolt lengths.

3.3.2   Expansion or Chemically Bonded Anchors

****

NOTE: Cast-in-place anchors should be used to anchor equipment for seismic loads since there is considerable experience suggesting that expansion and chemically bonded anchors may come loose during a fire, and do not perform well for vibrating equipment or for other types of cyclic loading, such as earthquakes.

Expansion and chemically bonded anchors should only be allowed when test data show they are applicable for seismic loading. ASTM E 488 provides a means of testing expansion anchors for seismic loading. In lieu of tests, the designer may specify approval of the expansion anchors by a governmental organization such as the City of Los Angeles or the State of California office of Statewide Health Planning and Development (OSHPD).

The edge distance and spacing between anchor bolts greatly affect the shear and tension capacity of the bolts. The spacing will depend on the type of anchor, the diameter, and the length of embedment.

The manufacturer should provide data for the minimum edge distance and bolt spacing needed to achieve the rated values and also ways to reduce the allowables if the edge distance or spacing is less than required.
****

Expansion or chemically bonded anchors shall not be used unless test data in accordance with ASTM E 488 has been provided to verify the adequacy of the specific anchor and application. Expansion or chemically bonded anchors shall not be used to resist pull-out in overhead and wall installations if the adhesive is manufactured with temperature sensitive epoxies and the location is accessible to a building fire. Expansion and chemically bonded anchors shall be installed in accordance with the manufacturer's recommendations. The allowable forces shall be adjusted for the spacing between anchor bolts and the distance between the anchor bolt and the nearest edge, as specified by the manufacturer.

3.3.2.1 General Testing

****
NOTE: Expansion and chemically bonded anchors should be tested after installation. Testing every expansion anchor is not necessary or practical; therefore a reasonable rate of testing should be developed depending on the importance of the job. There are two methods of testing: Torque wrench and pullout testing. The torque test is easier and cheaper and usually gives a good indication of installation quality; the pullout test gives a better indication of the strength of both expansion and chemically bonded anchors. The torque test does not apply to expansion bolts which are anchored by hammering the sleeve over a cone such as self drilling anchors.
****

Expansion and chemically bonded anchors shall be tested in place after installation. The tests shall occur not more than [24] [_____] hours after installation of the anchor and shall be conducted by an independent testing agency; testing shall be performed on random anchor bolts as described below.

3.3.2.2 Torque Wrench Testing

****
NOTE: Delete this paragraph for expansion anchors which are not anchored by an applied torque, such as self drilling anchors.

Torque wrench testing verifies that a torqued expansion anchor has seated properly. If it has not seated, the applied torque on the nut will cause the bolt to twist in the hole. Torque wrench testing does not load the bolt up to allowable load and therefore does not verify the capacity of the

installed bolt.
****

Torque wrench testing shall be done on not less than [50] [_____] percent of the total installed expansion anchors and at least [one anchor] [[_____] anchors] for every piece of equipment containing more than [two] [_____] anchors. The test torque shall equal the minimum required installation torque as required by the bolt manufacturer. Torque wrenches shall be calibrated at the beginning of each day the torque tests are performed. Torque wrenches shall be recalibrated for each bolt diameter whenever tests are run on bolts of various diameters. The applied torque shall be between 20 and 100 percent of wrench capacity. The test torque shall be reached within one half turn of the nut, except for 3/8 inch sleeve anchors which shall reach their torque by one quarter turn of the nut. If any anchor fails the test, similar anchors not previously tested shall be tested until [20] [_____] consecutive anchors pass. Failed anchors shall be retightened and retested to the specified torque; if the anchor still fails the test it shall be replaced.

3.3.2.3   Pullout Testing

****
NOTE: Pullout testing is expensive and labor intensive because of the apparatus needed to pull on the anchor bolt. Pullout testing determines the tension capacity of the anchor bolt. The amount of load to be applied can vary between 0.5 to 2 times the calculated load, depending on the importance of the bolt. There is not a significant cost difference between testing to 0.5 or 2 times the calculated load; since most anchor bolts have a factor of safety of 4, testing to twice the specified load should not cause any distress. The typical tension failure causes a shear cone to be pulled out of the concrete, the slope of the cone is about a 45 degree angle so there should be nothing on the concrete surface in the vicinity of the bolt to prevent the cone from pulling out. Shear testing is usually not needed unless the bolt is heavily loaded in shear and close to an edge.
****

Expansion and chemically bonded anchors shall be tested by applying a pullout load using a hydraulic ram attached to the anchor bolt. At least [5] [_____] percent of the anchors, but not less than [3] [_____] per day shall be tested. The load shall be applied to the anchor without removing the nut; when that is not possible, the nut shall be removed and a threaded coupler shall be installed of the same tightness as the original nut. The test setup shall be checked to verify that the anchor is not restrained from withdrawing by the baseplate, the test fixture, or any other fixtures. The support for the testing apparatus shall be at least 1.5 times the embedment length away from the bolt being tested. Each tested anchor shall be loaded to [1] [_____] times the design tension value for the anchor. The anchor shall have no observable movement at the test load. If any anchor fails the test, similar anchors not previously tested shall be tested until [20] [_____] consecutive anchors pass. Failed anchors shall be retightened and retested to the specified load; if the anchor still fails the test it shall be replaced.

3.4 RESILIENT VIBRATION ISOLATION DEVICES

Where the need for these devices is determined, based on the magnitude of the design seismic forces, selection of anchor bolts for vibration isolation devices and/or snubbers for equipment base and foundations shall follow the same procedure as in paragraph ANCHOR BOLTS, except that an equipment weight equal to [five] [_____] times the actual equipment weight shall be used.

3.4.1 Resilient and Spring-Type Vibration Devices

****
NOTE: Retain either this paragraph or the one below, as required by the project. Remove the paragraph not needed.
****

Vibration isolation devices shall be selected so that the maximum movement of equipment from the static deflection point shall be 0.5 inches.

3.4.2 Multidirectional Seismic Snubbers

****
NOTE: Details of multidirectional seismic snubbers will be shown in drawings if paragraph is retained.
****

Multidirectional seismic snubbers employing elastomeric pads shall be installed on floor- or slab-mounted equipment. These snubbers shall provide 0.25 inches free vertical and horizontal movement from the static deflection point. Snubber medium shall consist of multiple pads of cotton duct and neoprene or other suitable materials arranged around a flanged steel trunnion so both horizontal and vertical forces are resisted by the snubber medium.

3.5 SWAY BRACES FOR PIPING

****
The bracing requirements shown below are based on flexible piping. Supports for flexible piping must consider an additional amplification of the piping being in resonance with the building.
****

Transverse sway bracing for steel and copper pipe shall be provided at intervals not to exceed those shown on the drawings. Transverse sway bracing for pipes of materials other than steel and copper shall be provided at intervals not to exceed the hanger spacing as specified in Section 15400 PLUMBING, GENERAL PURPOSE. Bracing shall consist of at least one vertical angle 2 x 2 x 16 gauge and one diagonal angle of the same size.

3.5.1 Longitudinal Sway Bracing

Longitudinal sway bracing shall be provided in accordance with Section 15070 SEISMIC CONTROL FOR MECHANICAL EQUIPMENT.

3.5.2 Anchor Rods, Angles, and Bars

Anchor rods, angles, and bars shall be bolted to either pipe clamps or pipe flanges at one end and cast-in-place concrete or masonry insert or clip angles bolted to the steel structure on the other end. Rods shall be solid metal or pipe as specified below. Anchor rods, angles, and bars shall not exceed lengths given in the tabulation below.

3.5.3 Maximum Length for Anchor Braces

Type	Size (Inches)	Maximum Length* (Feet/Inches)
Angles	1-1/2 x 1-1/2 x 1/4	4-10
	2 x 2 x 1/4	6-6
	2-1/2 x 1-1/2 x 1/4	8-0
	3 x 2-1/2 x 1/4	8-10
	3 x 3 x 1/4	9-10
Rods	3/4	3-1
	7/8	3-8
Flat Bars	1-1/2 x 1/4	1-2
	2 x 1/4	1-2
	2 x 3/8	1-9
Pipes (40S)	1	7-0
	1-1/4	9-0
	1-1/2	10-4
	2	13-1

3.5.4 Bolts

Bolts used for attachment of anchors to pipe and structure shall be not less than 1/2 inch diameter.

3.6 EQUIPMENT SWAY BRACING

3.6.1 Suspended Equipment and Light Fixtures

****

NOTE: Equipment weighing more than one-fifth of the dead load of slabs above grade at the equipment level or equipment weighing more than one-tenth of the building weight must be checked by structural analysis to conform with building seismic provisions. Such equipment has a pronounced effect on the response of the building. The following items shall be checked structurally and specific seismic requirements incorporated on appropriate drawings and in the relevant specifications.

Pole or frame supported equipment.

Storage tanks for water and oil.

Storage racks with upper storage level more than 2.4 m (8 feet) in height.

Smoke stacks taller than 15 m (50 feet) in height.

See Chapter 10 of TI 809-04 to compute the force needed to fill in the bracketed blank.
****

Equipment sway bracing shall be provided for items supported from overhead floor or roof structural systems, including light fixtures. Braces shall consist of angles, rods, wire rope, bars, or pipes arranged as shown and secured at both ends with not less than 1/2 inch bolts. Sufficient braces shall be provided for equipment to resist a horizontal force equal to [_____] times the weight of equipment without exceeding safe working stress of bracing components. Details of equipment bracing shall be submitted for acceptance. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45-degree angle.

3.6.2 Floor or Pad Mounted Equipment

3.6.2.1 Shear Resistance

Floor mounted equipment shall be bolted to the floor. Requirements for the number and installation of bolts to resist shear forces shall be in accordance with paragraph ANCHOR BOLTS.

3.6.2.2 Overturning Resistance

****
NOTE: See Chapter 10 of TI 809-04 for guidance on design of anchor bolts.
****

The ratio of the overturning moment from seismic forces to the resisting moment due to gravity loads shall be used to determine if overturning forces need to be considered in the sizing of anchor bolts. Calculations shall be provided to verify the adequacy of the anchor bolts for combined shear and overturning.

-- End of Section --

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 13110

CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)
11/98

****

NOTE: This guide specification covers the requirements for a cathodic protection system utilizing continuous flow direct current from sacrificial anodes. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

PART 1 GENERAL

****

NOTE: This specification covers a cathodic protection system for metal surfaces against corrosion by producing a continuous flow of direct current from sacrificial anodes to the metal to be protected. The anodes should be of sufficient size and quantity to protect the buried metal items for a specified number of years before replacement. The U.S. Department of Transportation has issued regulations requiring the application of cathodic protection to natural gas pipelines, liquid natural gas pipelines, petroleum pipelines, petroleum products pipelines, liquid petroleum gas pipelines, and petroleum storage facilities. Title 49 of the Code of Federal Regulations, Parts 191, 192, 193 and 195 should be consulted for applicable cathodic

protection requirements for specific applications.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 418	(1995a) Cast and Wrought Galvanic Zinc Anodes
ASTM B 843	(1996) Magnesium Alloy Anodes for Cathodic Protection
ASTM D 1248	(1984; R 1989) Polyethylene Plastics Molding and Extrusion Materials

CODE OF FEDERAL REGULATIONS (CFR)

40 CFR 280	Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Fuel Storage Tanks (UST)
49 CFR 192	Transportation of Natural and other Gas by Pipeline: Minimum Federal Safety Standards
49 CFR 195	Transportation of Hazardous Liquids by Pipeline

NACE INTERNATIONAL (NACE)

NACE RP0169	(1996) Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE RP0177	(1995) Mitigation of Alternating Current and Lightning Effects on Metallic Piping Systems
NACE RP0188	(1990) Discontinuity (Holiday) Testing of Protective Coatings
NACE RP0190	(1995) External Protective Coatings for Joints, Fittings, and Valves on Metallic Underground or Submerged Pipelines and Piping Systems
NACE RP0193	(1993) External Cathodic Protection of

	On-Grade Metallic Storage Tank Bottoms
NACE RP0285	(1995) Corrosion Control of Underground Storage Tank Systems by Cathodic Protection

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA TC 2	(1990) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)
NEMA WC 5	(1992; Rev 1) Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996; Errata 96-4) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1997) Rigid Metal Conduit
UL 510	(1994; Rev thru Nov 1997) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 514A	(1996; Rev Jul 1998) Metallic Outlet Boxes

1.2 GENERAL REQUIREMENTS

The Contractor shall furnish and install a complete, operating, sacrificial anode cathodic protection system in complete compliance with NFPA 70, with all applicable Federal, State, and local regulations and with minimum requirements of this contract. In addition to the minimum requirements of these specifications, [construction of gas pipelines and associated cathodic protection systems shall be in compliance with 49 CFR 192] [and] [construction of hazardous liquid pipelines, including fuel pipelines, and associated cathodic protection systems shall be in compliance with 49 CFR 195] [and] [construction and installation of underground fuel storage tanks and associated cathodic protection system shall be in compliance with 40 CFR 280]. The services required include planning, installation, adjusting and testing of a cathodic protection system, using sacrificial anodes for cathodic protection of the [Water] [Fire Protection] [Force Main] [Gas] [_____] lines, their connectors and [lines under the slab or floor foundation.] The cathodic protection system shall include anodes, cables, connectors, corrosion protection test stations, and any other equipment required for a complete operating system providing the NACE criteria of protection as specified. Insulators are required whenever needed to insulate the pipes from any other structure. Any pipe crossing the [_____] pipe shall have a test station. The cathodic protection shall be provided on [Water] [Fire Protection] [Force Main] [Gas] [_____] pipes.

1.2.1 Services of "Corrosion Expert"

The Contractor shall obtain the services of a "corrosion expert" to supervise, inspect, and test the installation and performance of the cathodic protection system. "Corrosion expert" refers to a person, who by thorough knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control of buried or submerged metallic surfaces. Such a person must be accredited or certified by the National Association of Corrosion Engineers (NACE) as a NACE Accredited Corrosion Specialist or a NACE certified Cathodic Protection (CP) Specialist or be a registered professional engineer who has certification or licensing that includes education and experience in corrosion control of buried or submerged metallic piping and tank systems, if such certification or licensing includes 5 years experience in corrosion control on underground metallic surfaces of the type under this contract. The "corrosion expert" shall make at least 3 visits to the project site. The first of these visits shall include obtaining soil resistivity data, acknowledging the type of pipeline coatings to be used and reporting to the Contractor the type of cathodic protection required. Once the submittals are approved and the materials delivered, the "corrosion expert" shall revisit the site the ensure the Contractor understands installation practices and laying out the components. The third visit shall involve testing the installed cathodic protection systems and training applicable personnel on proper maintenance techniques. The "corrosion expert" shall supervise installation and testing of all cathodic protection.

1.2.2 Contractor's Modifications

The specified system is based on a complete system with magnesium sacrificial anodes. The Contractor may modify the cathodic protection system after review of the project, site verification, and analysis, if the proposed modifications include the anodes specified and will provide better overall system performance. The modifications shall be fully described, shall be approved by the Contracting Officer's representative, and shall meet the following criteria. The proposed system shall achieve a minimum pipe-to-soil "instant off" potential of minus 850 millivolts with reference to a saturated copper-copper sulfate reference cell on the underground components of the piping or other metallic surface. The Contractor shall take resistivity measurements of the soil in the vicinity of the pipes and ground bed sites. Based upon the measurements taken, the current and voltage shall be required to produce a minimum of minus 850 millivolts "instant off" potential between the structure being tested and the reference cell. This potential shall be obtained over 95 percent of the metallic area. The anode system shall be designed for a life of twenty-five (25) years of continuous operation.

1.2.3 Isolators

Isolators are required to insulate the indicated pipes from any other structure. Isolators shall be provided with lightning protection and a test station as shown.

1.2.4 Anode and Bond Wires

A minimum of [5] [8] [25] [_____] magnesium anodes with an unpackaged weight of [_____] poundsshall be provided uniform distances along the metallic pipe lines. A minimum of [3] [5] [10] [_____] test stations shall be used for these anodes. These anodes shall be in addition to anodes for the pipe under concrete slab and casing requirements. For each cathodic system, the metallic components and structures to be protected shall be made electrically continuous. This shall be accomplished by installing bond wires between the various structures. Bonding of existing buried structures may also be required to preclude detrimental stray current effects and safety hazards. Provisions shall be included to return stray current to its source without damaging structures intercepting the stray current. The electrical isolation of underground facilities in accordance with acceptable industry practice shall be included under this section. All tests shall be witnessed by the Contracting Officer.

1.2.5 Surge Protection

Approved zinc grounding cells or sealed weatherproof lightning arrestor devices shall be installed across insulated flanges or fittings installed in underground piping as indicated on the drawings. The arrestor shall be gapless, self-healing, solid state type. Zinc anode composition shall conform to ASTM B 418, Type II. Lead wires shall be number 6 AWG copper with high molecular weight polyethylene (HMWPE) insulation. The zinc grounding cells shall not be prepackaged in backfill but shall be installed as detailed on the drawings. Lightning arrestors or zinc grounding cells are not required for insulated flanges on metallic components used on nonmetallic piping systems.

1.2.6 Summary of Services Required

The scope of services shall include, but shall not be limited to, the following:

a. Close-interval potential surveys.

b. Cathodic Protection Systems.

c. System testing.

d. Casing corrosion control.

e. Interference testing.

f. Training.

g. Operating and maintenance manual.

h. Insulator testing and bonding testing.

i. Coating and holiday testing shall be submitted within 45 days of notice to proceed.

1.2.7 Nonmetallic Pipe System

In the event pipe other than metallic pipe is approved and used in lieu of metallic pipe, all metallic components of this pipe system shall be protected with cathodic protection. Detailed drawings of cathodic protection for each component shall be submitted to the Contracting Officer for approval within 45 days after date of receipt of notice to proceed, and before commencement of any work.

1.2.7.1 Coatings

Coatings for metallic components shall be as required for metallic fittings. Protective covering (coating and taping) shall be completed and tested on each metallic component (such as valves, hydrants and fillings). This covering shall be as required for underground metallic pipe. Each test shall be witnessed by the Contracting Officer. Coatings shall be selected, applied, and inspected in accordance with NACE RP0190 and as specified in these specifications. The use of nonmetallic pipe does not change other requirements of the specifications. Any deviations due to the use of nonmetallic pipe shall be submitted for approval.

1.2.7.2 Tracer Wire

When a nonmetallic pipe line is used to extend or add to an existing metallic line, an insulated No. 8 AWG copper wire shall be thermit-welded to the existing metallic line and run the length of the new nonmetallic line. This wire shall be used as a locator tracer wire and to maintain continuity to any future extensions of the pipe line.

1.2.8 Tests of Components

A minimum of four (4) tests shall be made at each metallic component in the piping system. Two (2) measurements shall be made directly over the anodes and the other two (2) tests shall be over the outer edge of the component, but at the farthest point from the anodes. Structure and pipes shall be shown with the cathodic protection equipment. All components of the cathodic protection system shall be shown on drawings, showing their relationship to the protected structure or component. A narrative shall describe how the cathodic protection system will work and provide testing at each component. Components requiring cathodic protection shall include but not be limited to the following:

a. Pipes under the floor slab or foundations.

b. PIV.

c. Shutoff valves.

d. Metallic pipe extended from aboveground locations.

e. Each connector or change-of-direction device.

f. Any metallic pipe component or section.

g. Backflow preventor.

h. Culvert.

1.2.9 Drawings

Detailed drawings shall be provided showing location of anodes, insulated fittings, test stations, permanent reference cells, and bonding. Locations shall be referenced to two (2) permanent facilities or mark points.

1.2.10 Electrical Potential Measurements

All potential tests shall be made at a minimum of 10 foot intervals witnessed by the Contracting Officer. Submittals shall identify test locations on separate drawing, showing all metal to be protected and all cathodic protection equipment. Test points equipment and protected metal shall be easily distinguished and identified.

1.2.11 Achievement of Criteria for Protection

All conductors, unless otherwise shown, shall be routed to or through the test stations. Each system provided shall achieve a minimum pipe-to-soil "instant off" potential of minus 850 millivolt potentials with reference to a saturated copper-copper-sulfate reference cell on all underground components of the piping. Based upon the measurements taken, the current and voltage of the anodes should be adjusted as required to produce a minimum of minus 850 millivolts "instant off" potential between the structure being tested and the reference cell. This potential should be obtained over 95 percent of the metallic area. This must be achieved without the "instant off" potential exceeding 1150 millivolts. Testing will be witnessed by the Contracting Officer. Additional anodes shall be provided by the Contractor if required to achieve the minus 850 millivolts "instant off". Although acceptance criteria of the cathodic protection systems are defined in NACE RP0169, for this project the "instant off" potential of minus 850 millivolts is the only acceptable criteria.

1.2.12 Metallic Components and Typicals

a. Metallic components: As a minimum, each metallic component shall be protected with two (2) magnesium anodes. This number of anodes is required to achieve minus 850 millivolts "instant off" potential on the metallic area and at the same time not provide overvoltage above 1150 millivolts "instant off." As a minimum, the magnesium anode unpackaged weight shall be [9] [17] [_____] pounds. The magnesium anodes shall be located on each side of the metallic component and routed through a test station.

b. Fire Hydrants: Fire hydrant pipe components shall have a minimum of two (2) anodes. These magnesium anodes shall have an unpackaged weight of 17 pounds.

c. Pipe Under Concrete Slab: Pipe under concrete slab shall have a minimum of [2] [3] [_____] magnesium anodes. These magnesium anodes shall have an unpackaged weight of [9] [17] [_____] pounds. Pipe under concrete slab shall have [1] [2] [_____] permanent reference electrodes located under the slab. One (1) permanent reference electrode shall be located where the pipe enters the concrete slab. All conductors shall be routed to a test station.

d. Valves: Each valve shall be protected with [1] [2] [_____] magnesium anodes. The magnesium anode shall have an unpackaged weight of [9] [17] [_____] pounds.

e. Metallic Pipe Component or Section: Each section of metallic pipe shall be protected with [2] [3] [_____] magnesium anodes. The magnesium anodes shall have an unpackaged weight of [9] [17] [_____] pounds.

f. Connectors or Change-of-Direction Devices: Each change-of-direction device shall be protected with [2] [3] [____] magnesium anodes. The magnesium anode shall have an unpackaged weight of [9] [17] [_____] pounds.

1.2.13 Metallic Component Coating

Coatings for metallic components shall be as required for metallic fittings as indicated. This will include fire hydrants, T's, elbows, valves, etc. Coatings shall be selected, applied, and inspected in accordance with NACE RP0190 and as specified in these specifications.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Materials and Equipment; GA.

Within [30] [_____] days after receipt of notice to proceed, an itemized list of equipment and materials including item number, quantity, and manufacturer of each item. The list shall be accompanied by a description of procedures for each type of testing and adjustments, including testing of coating for thickness and holidays. Installation of materials and equipment shall not commence until this submittal is approved.

Spare Parts; [_____].

Spare parts data for each different item of material and equipment specified, after approval of detail drawings and not later than six (6) months prior to the date of beneficial occupancy. The data shall include a complete list of parts, special tools, and supplies, with current unit prices and source of supply. One (1) spare anode of each type shall be furnished.

SD-04 Drawings

Cathodic Protection System; GA.

[Six] [_____] copies of detail drawings consisting of a complete list of equipment and material including manufacturer's descriptive and technical literature, catalog cuts, results of system design calculations including soil-resistivity, installation instructions and certified test data stating the maximum recommended anode current output density and the rate of gaseous production if any at that current density. Detail drawings shall contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will function properly as a unit.

Contractor's Modifications; GA.

[Six] [_____] copies of detail drawings showing proposed changes in location, scope of performance indicating any variations from, additions to, or clarifications of contract drawings. The drawings shall show proposed changes in anode arrangement, anode size and number, anode materials and layout details, conduit size, wire size, mounting details, wiring diagram, method for electrically-isolating each pipe, and any other pertinent information to proper installation and performance of the system.

SD-08 Statements

Services of "Corrosion Expert"; GA.

Evidence of qualifications of the "corrosion expert."

a.   The "corrosion expert's" name and qualifications shall be certified in writing to the Contracting Officer prior to the start of construction.

b.   Certification shall be submitted giving the name of the firm, the number of years of experience, and a list of not less than five (5) of the firm's installations three (3) or more years old that have been tested and found satisfactory.

SD-09 Reports

Tests and Measurements; [_____].

Test reports in booklet form tabulating all field tests and measurements performed, upon completion and testing of the installed system and including close interval potential survey, casing and interference tests, final system test verifying protection, insulated joint and bond tests, and holiday coating test. A certified test report showing that the connecting method has passed a 120-day laboratory test without failure at the place of connection, wherein the anode is subjected to maximum recommended current output while immersed in a three percent sodium chloride solution.

Contractor's Modifications; GA.

Final report regarding Contractor's modifications. The report shall include pipe-to-soil measurements throughout the affected area, indicating that the modifications improved the overall conditions, and current measurements for anodes. The following special materials and information are required: taping materials and conductors; zinc grounding cell, installation and testing procedures, and equipment; coating material; system design calculations for anode number, life, and parameters to achieve protective potential; backfill shield material and installation details showing waterproofing; bonding and waterproofing details; insulated resistance wire; exothermic weld equipment and material.

SD-13 Certificates

Cathodic Protection System; [_____].

Proof that the materials and equipment furnished under this section conform to the specified requirements contained in the referenced standards or publications. The label or listing by the specified agency will be acceptable evidence of such compliance.

SD-18 Records

Training Course ; [_____].

The proposed Training Course Curriculum (including topics and dates of discussion) indicating that all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations, including testing procedures included in the maintenance instructions, are to be covered.

SD-19 Operation and Maintenance Manuals

Cathodic Protection System; [_____].

Before final acceptance of the cathodic protection system, [six] [_____] copies of operating manuals outlining the step-by-step procedures required for system startup, operation, adjustment of current flow, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. [Six] [_____] copies of maintenance manual, listing routine maintenance procedures, recommendation for maintenance testing, possible breakdowns and repairs, and troubleshooting guides. The manuals shall include single-line diagrams for the system as installed; instructions in making pipe-to-reference cell and tank-to-reference cell potential measurements and frequency of monitoring; instructions for dielectric connections, interference and sacrificial anode bonds; instructions shall include precautions to ensure safe conditions during repair of pipe or other metallic systems. The instructions shall be neatly bound between permanent covers and titled "Operating and Maintenance Instructions." These instructions shall be submitted for the Contracting Officer's approval. The instructions shall include the following:

a. As-built drawings, to scale of the entire system, showing the locations of the piping, location of all anodes and test stations, locations of all insulating joints, and structure-to-reference cell potentials as measured during the tests required by Paragraph: TESTS AND MEASUREMENTS, of this section.

b. Recommendations for maintenance testing, including instructions in making pipe-to-reference cell potential measurements and frequency of testing.

c. All maintenance and operating instructions and nameplate data shall be in English.

d. Instructions shall include precautions to insure safe conditions during repair of pipe system.

PART 2 PRODUCTS

2.1 MAGNESIUM ANODES

A minimum of [2] [3] [10] [12] [_____] anodes shall be installed on the [Pipe] [Tank] [_____] system. See Paragraph METALLIC COMPONENTS AND TYPICALS for additional anodes under slab.

2.1.1 Anode Composition

Anodes shall be of high-potential magnesium alloy, made of primary magnesium obtained from sea water or brine, and not made from scrap metal. Magnesium anodes shall conform to ASTM B 843 and to the following analysis (in percents) otherwise indicated:

Aluminum, max.	0.010
Manganese, max.	0.50 to 1.30
Zinc	0.05
Silicon, max.	0.05
Copper, max.	0.02
Nickel, max.	0.001
Iron, Max.	0.03
Other impurities, max.	0.05 each or 0.3 max. total
Magnesium	Remainder

The Contractor shall furnish spectrographic analysis on samples from each heat or batch of anodes used on this project.

2.1.2 Dimensions and Weights

Dimensions and weights of anodes shall be approximately as follows:

TYPICAL MAGNESIUM ANODE SIZE

(Cross sections may be round, square, or D shaped)

NOMINAL WT. LBS.	APPROX. SIZE (IN)	NOMINAL GROSS WT lb PACKAGED IN BACKFILL	NOMINAL PACKAGE DIMENSIONS (IN)
3	3 X 3 X 5	8	5-1/4 X 5-1/4 X 8
5	3 X 3 X 8	13	5-1/4 X 5-1/4 X 11-1/4
9	3 X 3 X 14	27	5-1/4 X 20
12	4 X 4 X 12	32	7-1/2 X 18
17	4 X 4 X 17	45	7-1/2 X 24
32	5 X 5 X 20-1/2	68	8-1/2 X 28
50	7 X 7 X 16	100	10 X 24

2.1.3 Packaged Anodes

Anodes shall be provided in packaged form with the anode surrounded by specially-prepared quick-wetting backfill and contained in a water permeable cloth or paper sack. Anodes shall be centered by means of spacers in the backfill material. The backfill material shall have the following composition, unless otherwise indicated:

Material	Approximate Percent by Weight
Gypsum	75
Bentonite	20
Sodium Sulphate	5
Total	100

2.1.4 Zinc Anodes

Zinc anodes shall conform to ASTM B 418, Type II.

2.1.5 Connecting Wire

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NOTE: Any pinhole, cut, scratch or other damage to

the anode cable exposing bare copper to the electrolyte will result in early failure of the cathodic protection system. For this reason, special, extra heavy insulation is used on anode cable. While it is often expedient to use the same type wire for the cathodic (negative) cable in order to avoid a mix-up in the field, the cathode cable is not subject to anodic failure and lesser insulation can be used.

Type RHH insulation should be used under hot asphalt.

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2.1.5.1 Wire Requirements

Wire shall be No. [12] [10] [_____] AWG solid copper wire, not less than 10 feet long, unspliced, complying with NFPA 70, Type [TW] [RHH] insulation. [Connecting wires for magnesium anodes shall be factory installed with the place or emergence from the anode in a cavity sealed flush with a dielectric sealing compound.] [Connecting wires for zinc anodes shall be factory installed with the place of connection to the protruding steel core completely sealed with a dielectric material.]

2.1.5.2 Anode Header Cable

Cable for anode header and distribution shall be No. [_____] AWG stranded copper wire with type CP high molecular weight polyethylene, 7/64 inch thick insulation, 600-volt rating, in accordance with NEMA WC 5.

2.2 MISCELLANEOUS MATERIALS

2.2.1 Electrical Wire

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NOTE: The cathodic protection system will fail unless full consideration is given to specifications for electrically insulating pipe joints, electrically conductive pipe joints, and casing cradles and seals. Mechanical and electrical specifications should reference paragraphs "Electrically Isolating Pipe Joints" and "Electrically Conductive Couplings."

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Wire shall be No. [12] [10] [____] AWG stranded copper wire with NFPA 70, Type [TW] [RHW-USE] [RHW-USE] [Polyethylene] [_____] insulation. Polyethylene insulation shall comply with the requirements of ASTM D 1248 and shall be of the following types, classes, and grades:

High-molecular weight polyethylene shall be Type I, Class C, Grade E5.

High-density polyethylene shall be Type III, Class C, Grade E3.

2.2.1.1 Wire Splicing

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NOTE: In water tanks, split bolts are used (above the water line only) because working space is limited and the hydraulic or mechanical compression tools may be cumbersome and hazardous to use; since single split-bolt will work loose when the wires it connects are moved, minimum of two split bolts should be used. At ground level or in trenches, compression tools can be used conveniently, and the swaged sleeve connection produced by such tools is more reliable than split bolts.
****

Connecting wire splicing shall be made with copper compression connectors or exothermic welds, following instructions of the manufacturer. Single split-bolt connections shall not be used. Sheaths for encapsulating electrical wire splices to be buried underground shall fit the insulated wires entering the spliced joints and epoxy potting compound shall be as specified below.

2.2.1.2 Test Wires

Test wires shall be AWG No. 12 stranded copper wire with NFPA 70, Type TW or RHW or polyethylene insulation.

2.2.1.3 Resistance Wire

Resistance wire shall be AWG No. 16 or No. 22 nickel-chromium wire.

2.2.2 Conduit

Rigid galvanized steel conduit and accessories shall conform to UL 6. Non metallic conduit shall conform to NEMA TC 2.

2.2.3 Test Boxes and Junctions Boxes

Boxes shall be outdoor type conforming to UL 514A.

2.2.4 Joint, Patch, Seal, and Repair Coating

Sealing and dielectric compound shall be a black, rubber based compound that is soft, permanently pliable, tacky, moldable, and unbacked. Compound shall be applied as recommended by the manufacturer, but not less than 1/2-inch thick. Coating compound shall be [cold-applied coal-tar base mastic] [hot-applied coal-tar enamel]. Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

2.2.5 Backfill Shields

Shields shall consist of approved pipeline wrapping or fiberglass-reinforced, coal-tar impregnated tape, or plastic weld caps, specifically made for the purpose and installed in accordance with the manufacturer's recommendations. When joint bonds are required, due to the use of mechanical joints, the entire joint shall be protected by the use of a kraft paper joint cover. The joint cover shall be filled with poured-in, hot coat-tar enamel.

2.2.6 Epoxy Potting Compound

Compound for encapsulating electrical wire splices to be buried underground shall be a two package system made for the purpose.

2.2.7 Test Stations

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NOTE: Retain bracketed sentences only when nonmetallic materials are used in the project.
****

Stations shall be of the [aboveground] [flush-curb-box type] and shall be the standard product of a recognized manufacturer. Test stations shall be complete with an insulated terminal block having the required number of terminals. The test station shall be provided with a lockable over and shall have an embossed legend, "C.P. Test." A minimum of one (1) test station shall be provided each component of the [pipe] [tank] [_____]. A minimum of six (6) terminals shall be provided in each test station. A minimum of two (2) leads are required to the metallic pipe from each test station. Other conductors shall be provided for each anode, other foreign pipe, and reference cells as required. [Test stations may be constructed of nonmetallic materials. However, if nonmetallic materials are utilized, as a minimum, the materials shall be resistant to damage from ultraviolet radiation, contain good color retention qualities, contain high strength qualities, and be resistant to accidental or vandalistic impacts that might be normally encountered in the environment for which they are to be installed. The test stations shall be listed for the particular application for which they are to be utilized].

2.2.8 Joint and Continuity Bonds

Bonds shall be provided across all joints in the metallic [water] [gas] [_____] lines, across any electrically discontinuous connections and all other pipes and structures with other than welded or threaded joints that are included in this cathodic protection system. Unless otherwise specified in the specifications, bonds between structures and across joints in pipe with other than welded or threaded joints shall be No. 8 AWG stranded copper cable with polyethylene insulation. Bonds between structures shall contain sufficient slack for any anticipated movement between structures. Bonds across pipe joints shall contain a minimum of 4 inches of slack to allow for pipe movement and soil stress. Bonds shall be attached by exothermic welding. Exothermic weld areas shall be insulated with coating compound and approved, and witnessed by the Contracting Officer. Continuity bonds shall be installed as necessary to reduce stray current interference. Additional joint bondings shall be accomplished by the Contractor where the necessity is discovered during construction or testing or where the Contracting Officer's representative directs that such bonding be done. Joint bonding shall include all associated excavation and backfilling. There shall be a minimum of two (2) continuity bonds between each structure and other than welded or threaded joints. The Contractor shall test for electrical continuity across all joints with other than welded or threaded joints and across all metallic portions or components. The Contractor shall provide bonding as required and as specified above until electrical continuity is achieved. Bonding test data shall be submitted for approval.

2.2.9 Resistance Bonds

Resistance bonds should be adjusted as outlined in this specification. Alternate methods may be used if they are approved by the Contracting

Officer.

2.2.10   Stray Current Measurements

Stray current measurements should be performed at each test station. Stray currents resulting from lightning or overhead alternating current (AC) power transmission systems shall be mitigated in accordance with NACE RP0177.

2.2.11   Electrical Isolation of Structures

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NOTE: The cathodic protection system will fail unless full consideration is given to specifications for electrically insulating pipe joints, electrically conductive pipe joints, and casing cradles and seals. Mechanical and electrical specifications should reference paragraphs "Electrically Isolating Pipe Joints" and "Electrically Conductive Couplings."

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As a minimum, isolating flanges or unions shall be provided at the following locations:

a.   Connection of new metallic piping or components to existing piping.

b.   Pressure piping under floor slab to a building.

Isolation shall be provided at metallic connection of all lines to existing system and where connecting to a building. Additionally, isolation shall be provided between [water] [_____] and/or [gas] [_____] [forced main] line; and foreign pipes that cross the new lines within 10 feet. Isolation fittings, including isolating flanges and couplings, shall be installed aboveground or in a concrete pit.

2.2.11.1   Electrically Isolating Pipe Joints

Electrically isolating pipe joints shall be of a type that is in regular factory production.

2.2.11.2   Electrically Conductive Couplings

Electrically conductive couplings shall be of a type that has a published maximum electrical resistance rating given in the manufacturer's literature. Cradles and seals shall be of a type that is in regular factory production made for the purpose of electrically insulating the carrier pipe from the casing and preventing the incursion of water into the annular space.

2.2.11.3   Insulating Joint Testing

A Model 601 Insulation Checker, as manufactured by ["Gas Electronics"], [_____], [or] [an approved equal], shall be used for insulating joint (flange) electrical testing.

2.2.12   Underground Structure Coating

This coating specification shall take precedence over any other project specification and drawing notes, whether stated or implied, and shall also apply to the pipeline or tank supplier. No variance in coating quality shall be allowed by the Contractor or Base Construction Representative without the written consent of the designer. All underground metallic pipelines and tanks to be cathodically protected shall be afforded a good quality factory-applied coating. This includes all carbon steel, cast-iron and ductile-iron pipelines or vessels. Coatings shall be selected, applied, and inspected in accordance with NACE RP0190 and as specified. If non-metallic pipelines are installed, all metallic fittings on pipe sections shall be coated in accordance with this specification section.

a. The nominal thickness of the metallic pipe joint or other component coating shall be [8] [16] [24] [40] [60] [____] mils, plus or minus 5 percent.

b. Pipe and joint coating for factory applied or field repair material shall be applied as recommended by the manufacturer and shall be one of the following:

(1) Continuously extruded polyethylene and adhesive coating system.
(2) Polyvinyl chloride pressure-sensitive adhesive tape.
(3) High density polyethylene/bituminous rubber compound tape.
(4) Butyl rubber tape.
(5) Coal tar epoxy.

2.2.12.1 Field Joints

All field joints shall be coated with materials compatible with the pipeline coating compound. The joint coating material shall be applied to an equal thickness as the pipeline coating. Unbonded coatings shall not be used on these buried metallic components. This includes the elimination of all unbonded polymer wraps or tubes. Once the pipeline or vessel is set in the trench, an inspection of the coating shall be conducted. This inspection shall include electrical holiday detection. Any damaged areas of the coating shall be properly repaired. The Contracting Officer shall be asked to witness inspection of the coating and testing using a holiday detector.

2.2.12.2 Inspection of Pipe Coatings

Any damage to the protective covering during transit and handling shall be repaired before installation. After field coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current in accordance with NACE RP0188 using a full-ring, spring-type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. All holidays in the protective covering shall be repaired immediately upon detection. Occasional checks of holiday detector potential will be made by the Contracting Officer's representative to determine suitability of the detector. All labor, materials, and equipment necessary for conducting the inspection shall be furnished by the Contractor.

a. Protective covering for aboveground piping system: Finish painting shall conform to the applicable paragraph of SECTION: 09900, PAINTING, GENERAL, and as follows:

b. Ferrous surfaces: Shop-primed surfaces shall be touched-up with ferrous metal primer. Surfaces that have not been shop-primed shall be solvent-cleaned. Surfaces that contain loose rust, loose mil scale, and other foreign substances shall be mechanically-cleaned by power wire-brushing and primed with ferrous metal primer. Primed surface shall be finished with two (2) coats of exterior oil paint and vinyl paint. Coating for each entire piping service shall be an approved pipe line wrapping having a minimum coating resistance of 50,000 Ohms per square foot.

2.2.13 Resistance Wire

Wire shall be No. 16 or No. 22 nickel-chromium wire with TW insulation.

2.2.14 Electrical Connections

Electrical connections shall be done as follows:

a. Exothermic welds shall be ["Cadweld"],[" Bundy"], ["Thermoweld"] [or] [an approved equal]. Use of this material shall be in strict accordance with the manufacturer's recommendations.

b. Electrical-shielded arc welds shall be approved for use on steel pipe by shop drawing submittal action.

c. Brazing shall be as specified in Paragraph: Lead Wire Connections.

2.2.15 Electrical Tape

Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

2.2.16 Permanent Reference Electrodes

Permanent reference electrodes shall be Cu-CuS04 electrodes suitable for direct burial. Electrodes shall be guaranteed by the supplier for 15 years' service in the environment in which they shall be placed. Electrodes shall be installed directly beneath pipe, or metallic component.

2.2.17 Casing

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NOTE: This paragraph will be deleted if mechanical and electrical specifications include these requirements.
****

Where a pipeline is installed in a casing under a roadway or railway, the pipeline shall be electrically insulated from the casing, and the annular space sealed and filled with an approved corrosion inhibiting product against incursion of water.

PART 3 EXECUTION

3.1 CRITERIA OF PROTECTION

Acceptance criteria for determining the adequacy of protection on a buried underground [pipe] [tank] [metallic component] shall be in accordance with [NACE RP0169] [NACE RP0193] [NACE RP0285] and as specified below.

3.1.1 Iron and Steel

The following method (a) shall be used for testing cathodic protection voltages. If more than one method is required, method (b) shall be used.

a. A negative voltage of at least minus 850 millivolts as measured between the underground component and a saturated copper-copper sulphate reference electrode connecting the earth (electrolyte) directly over the underground component. Determination of this voltage shall be made with the cathodic protection system in operation. Voltage drops shall be considered for valid interpretation of this voltage measurement. A minimum of minus 850 millivolts "instant off" potential between the underground component being tested and the reference cell shall be achieved over 95 percent of the area of the structure. Adequate number of measurements shall be obtained over the entire structure, pipe, tank, or other metallic component to verify and record achievement of minus 850 millivolts "instant off." This potential shall be obtained over 95 percent of the total metallic area without the "instant off" potential exceeding 1200 millivolts.

b. A minimum polarization voltage shift of 100 millivolts as measured between the underground component and a saturated copper-copper sulphate reference electrode contacting the earth directly over the underground component. This polarization voltage shift shall be determined by interrupting the protective current and measuring the polarization decay. When the protective current is interrupted, an immediate voltage shift will occur. The voltage reading, after the immediate shift, shall be used as the base reading from which to measure polarization decay. Measurements achieving 100 millivolts decay shall be made over 95 percent of the metallic surface being protected.

c. For any metallic component, a minimum of four (4) measurements shall be made using subparagraph (a), above, and achieving the "instant off" potential of minus 850 millivolts. Two (2) measurements shall be made over the anodes and two (2) measurements shall be made at different locations near the component and farthest away from the anode.

3.1.2 Aluminum

Aluminum underground component shall not be protected to a potential more negative than minus 1200 millivolts, measured between the underground component and a saturated copper-copper sulphate reference electrode contacting the earth, directly over the metallic component. Resistance, if required, shall be inserted in the anode circuit within the test station to reduce the potential of the aluminum to a value which will not exceed a potential more negative than minus 1200 millivolts. Voltage shift criterion shall be a minimum negative polarization shift of 100 millivolts measured between the metallic component and a saturated copper-copper sulphate reference electrode contacting the earth, directly over the metallic component. The polarization voltage shift shall be determined as outlined for iron and steel.

3.1.3 Copper Piping

For copper piping, the following criteria shall apply: A minimum of 100 millivolts of cathodic polarization between the structure surface and a stable reference electrode contacting the electrolyte. The polarization voltage shift shall be determined as outlined for iron and steel.

3.2 ANODE STORAGE AND INSTALLATION

3.2.1 Anode Storage

Storage area for magnesium anodes will be designated by the Contracting Officer. If anodes are not stored in a building, tarps or similar protection should be used to protect anodes from inclement weather. Packaged anodes, damaged as a result of improper handling or being exposed to rain, shall be resacked by the Contractor and the required backfill added.

3.2.2 Anode Installation

Unless otherwise authorized, installation shall not proceed without the presence of the Contracting Officer. Anodes of the size specified shall be installed to the depth indicated and at the locations shown. Locations may be changed to clear obstructions with the approval of the Contracting Officer. Anodes shall be installed in sufficient number and of the required type, size, and spacing to obtain a uniform current distribution over the surface of the structure. The anode system shall e designed for a life of 25 years of continuous operation. Anodes shall be installed as indicated in a dry condition after any plastic or waterproof protective covering has been completely removed from the water permeable, permanent container housing the anode metal. The anode connecting wire shall not be used for lowering the anode into the hole. The annular space around the anode shall be backfilled with fine earth in 6 inch layers and each layer shall be hand tamped. Care must be exercised not to strike the anode or connecting wire with the tamper. Approximately 5 gallonsof water shall be applied to each filled hole after anode backfilling and tamping has been completed to a point about 6inches above the anode. After the water has been absorbed by the earth, backfilling shall be completed to the ground surface level.

3.2.2.1 Single Anodes

Single anodes, spaced as shown, shall be [connected] [connected through a test station] to the pipeline, allowing adequate slack in the connecting wire to compensate for movement during backfill operation.

3.2.2.2 Groups of Anodes

Groups of anodes, in quantity and location shown, shall be connected to an anode header cable. The anode header cable shall make contact with the structure to be protected only through a test station. Anode lead connection to the anode header cable shall be made by an approved crimp connector or exothermic weld and splice mold kit with appropriate potting compound.

3.2.2.3 Welding Methods

Connections to [ferrous pipe] [metal tanks] shall be made by exothermic weld methods manufactured for the type of [pipe] [tank] supplied. Electric arc welded connections and other types of welded connections to ferrous pipe and structures shall be approved before use.

3.2.3 Anode Placement - General

Packaged anodes shall be installed completely dry, and shall be lowered into holes by rope sling or by grasping the cloth gather. The anode lead wire shall not be used in lowering the anodes. The hole shall be backfilled with fine soil in 6inch layers and each layer shall be hand-tamped around the anode. Care must be exercised not to strike the anode or lead wire with the tamper. If immediate testing is to be performed, water shall be added only after backfilling and tamping has been completed to a point 6 inches above the anode. Approximately 2 gallons of water may be poured into the hole. After the water has been absorbed by the soil, backfilling and tamping may be completed to the top of the hole. Anodes shall be installed as specified or shown. In the event a rock strata is encountered prior to achieving specified augered-hole depth, anodes may be installed horizontally to a depth at least as deep as the bottom of the pipe, with the approval of the Contracting Officer.

3.2.4 Underground Pipeline

Anodes shall be installed at a minimum of 8 feet and a maximum of 10 feet from the line to be protected.

3.2.5 Installation Details

Details shall conform to the requirements of this specification. Details shown on the drawings are indicative of the general type of material required, and are not intended to restrict selection to material of any particular manufacturer.

3.2.6 Lead Wire Connections

3.2.6.1 Underground Pipeline (Metallic)

To facilitate periodic electrical measurements during the life of the sacrificial anode system and to reduce the output current of the anodes, if required, all anode lead wires shall be connected to a test station and buried a minimum of 24 inches in depth. The cable shall be No. 10 AWG, stranded copper, polyethylene or RHW-USE insulated cable. The cable shall make contact with the structure only through a test station. Resistance wire shall be installed between the cable and the pipe cable, in the test station, to reduce the current output, if required. Anode connections, except in the test station, shall be made with exothermic welding process, and shall be insulated by means of at least three (3) layers of electrical tape; and all lead wire connections shall be installed in a moistureproof splice mold kit and filled with epoxy resin. Lead wire-to-structure connections shall be accomplished by an exothermic welding process. All welds shall be in accordance with the manufacturer's recommendations. A backfill shield filled with a pipeline mastic sealant or material compatible with the coating shall be placed over the weld connection and shall be of such diameter as to cover the exposed metal adequately.

3.2.6.2 Resistance Wire Splices

Resistance wire connections shall be accomplished with silver solder and the solder joints wrapped with a minimum of three (3) layers of pressure-sensitive tape. Lead wire connections shall be installed in a moistureproof splice mold kit and filled with epoxy resin.

3.2.7 Location of Test Stations

Test stations shall be of the type and location shown and shall be [curb box] [post] [indoor] mounted. Buried insulating joints shall be provided with test wire connections brought to a test station. Unless otherwise shown, other test stations shall be located as follows:

a.   At 1,000-foot intervals or less.

b.   Where the pipe or conduit crosses any other metal pipe.

c.   At both ends of casings under roadways and railways.

d.   Where both sides of an insulating joint are not accessible above ground for testing purposes.

3.2.8   Underground Pipe Joint Bonds

Underground pipe having other than welded or threaded coupling joints shall be made electrically continuous by means of a bonding connection installed across the joint.

3.3   ELECTRICAL ISOLATION OF STRUCTURES

****

NOTE: The cathodic protection system will fail unless full engineering considerations are applied to selection, location and installation of electrically conductive joints and electrically isolating joints including the use of underground type dielectric coatings (not paint).

Adequate electrical conductivity of a pipe joint made by means other than welding should be determined by a "corrosion expert." The "corrosion expert" must be accredited or certified by the National Association of Corrosion Engineers (NACE) as a NACE Accredited Corrosion Specialist or a NACE certified Cathodic Protection (CP) Specialist or be a registered professional engineer who has certification or licensing that includes education and experience in corrosion control. Allowable electrical resistance depends on the cross sectional area of the pipe metal, the resistivity of the pipe metal, and the effectiveness of the coating on the pipe. Effectively coated pipe underground requires only a fraction of the electrical conductivity at joints needed for bare pipe. Shop painted pipe is considered to be the same as bare pipe and is not to be confused with pipe coated with an underground type dielectric coating.

The type of electrical isolating pipe joint to be used requires engineering design consideration. In general, the dielectric parts of an isolating joint will not withstand structural or environmental stresses as well as an all-metal type of joint. If the pipe on the cathodic protected side of the underground electrically isolating pipe joint, including the joint, is not effectively coated,

interference type corrosion may occur unless other measures are taken. Factors to be considered include:

a. Deflection stresses

b. Pull-out stresses

c. Expansion-contraction due to temperature changes

d. Is function as a union necessary?

e. Is field assembly of critical parts practical?

f. Hazardous locations to be avoided

g. Accessibility if above ground

h. Location of test box if below ground

i. Importance of coating the adjacent pipe if below ground

j. Vulnerability to short circuiting

Factor of safety on pull-out strength required has to be engineered for the specific conditions involved since no blanket provisions are fully applicable to all cases. The requirement for isolating flanges or couplings should be based on a study of the conditions. If the new piping is a short extension to an existing old piping system not under cathodic protection, an isolating fitting should be installed at the point of connection, since the new piping will be anodic to the older system. If the older system is under cathodic protection, no isolating fitting should be used.
****

3.3.1 Isolation Joints and Fittings

Isolating fittings, including main line isolating flanges and couplings, shall be installed aboveground, or within manholes, wherever possible. Where isolating joints must be covered with soil, they shall be fitted with a paper joint cover specifically manufactured for covering the particular joint, and the space within the cover filled with hot coal-tar enamel. Isolating fittings in lines entering buildings shall be located at least 12 inches above grade of floor level, when possible. Isolating joints shall be provided with grounding cells to protect against over-voltage surges or approved surge protection devices. The cells shall provide a low resistance across isolating joint without excessive loss of cathodic current.

3.3.2 Gas Distribution Piping

Electrical isolation shall be provided at each building riser pipe to the pressure regulator, at all points where a short to another structure or to a foreign structure may occur, and at other locations as indicated on the drawings.

3.4 TRENCHING AND BACKFILLING

Trenching and backfilling shall be in accordance with [Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITY SYSTEMS] [_____].

3.5 TESTS AND MEASUREMENTS

3.5.1 Baseline Potentials

Each test and measurement will be witnessed by the Contracting Officer. The Contractor shall notify the Contracting Officer a minimum of five (5) working days prior to each test. After backfill of the [pipe] [tank], the static potential-to-soil of the [pipe] [tank] shall be measured. The locations of these measurements shall be identical to the locations specified for [pipe-][tank-]to-reference electrode potential measurements. The initial measurements shall be recorded.

3.5.2 Isolation Testing

Before the anode system is connected to the [pipe][tank], an isolation test shall be made at each isolating joint or fitting. This test shall demonstrate that no metallic contact, or short circuit exists between the two isolated sections of the [pipe][tank]. Any isolating fittings installed and found to be defective shall be reported to the Contracting Officer.

3.5.2.1 Insulation Checker

A Model 601 insulation checker, as manufactured by ["Gas Electronics",] [_____] [or] [an approved equal], using the continuity check circuit, shall be used for isolating joint (flange) electrical testing. Testing shall conform to the manufacturer's operating instructions. Test shall be witnessed by the Contracting Officer. An isolating joint that is good will read full scale on the meter. If an isolating joint is shorted, the meter pointer will be deflected or near zero on the meter scale. Location of the fault shall be determined from the instructions, and the joint shall be repaired. If an isolating joint is located inside a vault, the pipe shall be sleeved with insulator when entering and leaving the vault.

3.5.2.2 Cathodic Protection Meter

A Model B3A2 cathodic protection meter, as manufactured by ["M.C. Miller",] [_____] [or] [an approved equal], using the continuity check circuit, shall be used for isolating joint (flange) electrical testing. This test shall be performed in addition to the Model 601 insulation checker. Continuity is checked across the isolation joint after the test lead wire is shorted together and the meter adjusted to scale. A full-scale deflection indicates the system is shorted at some location. The Model 601 verifies that the particular insulation under test is good and the Model B3A2 verifies that the system is isolated. If the system is shorted, further testing shall be performed to isolate the location of the short.

3.5.3 Anode Output

As the anodes or groups of anodes are connected to the [pipe] [tank]

[_____], current output shall be measured with an approved clamp-on milliammeter, calibrated shunt with a suitable millivoltmeter or multimeter, or a low resistance ammeter. (Of the three methods, the low-resistance ammeter is the least desirable and most inaccurate. The clamp-on milliammeter is the most accurate.) The valves obtained and the date, time, and location shall be recorded.

3.5.4 Reference Electrode Potential Measurements

Upon completion of the installation and with the entire cathodic protection system in operation, electrode potential measurements shall be made using a copper-copper sulphate reference electrode and a potentiometer-voltmeter, or a direct-current voltmeter having an internal resistance (sensitivity) of not less than 10 megohms per volt and a full scale of 10 volts. The locations of these measurements shall be identical to the locations used for baseline potentials. The values obtained and the date, time, and locations of measurements shall be recorded. No less than eight (8) measurements shall be made over any length of line or component. Additional measurements shall be made at each distribution service riser, with the reference electrode placed directly over the service line.

3.5.5 Location of Measurements

3.5.5.1 Piping or Conduit

For coated piping or conduit, measurements shall be taken from the reference electrode located in contact with the earth, directly over the pipe. Connection to the pipe shall be made at service risers, valves, test leads, or by other means suitable for test purposes. Pipe-to-soil potential measurements shall be made at intervals not exceeding [5][10] [_____] feet. The Contractor may use a continuous pipe-to-soil potential profile in lieu of 5 foot interval pipe-to-soil potential measurements. Additional measurements shall be made at each distribution service riser, with the reference electrode placed directly over the service line adjacent to the riser. Potentials shall be plotted versus distance to an approved scale. Locations where potentials do not meet or exceed the criteria shall be identified and reported to the Contracting Officer's representative.

3.5.5.2 Tanks

For underground tanks, measurements shall be taken from the reference electrode located:

a. Directly over the center of the tank.

b. At a point directly over the tank and midway between each pair of anodes.

At least [six] [_____] measurements shall be made.

3.5.5.3 Casing Tests

Before final acceptance of the installation, the electrical separation of carrier pipe from casings shall be tested and any short circuits corrected.

3.5.5.4 Interference Testing

****

NOTE: Adverse effects may be caused by the foreign

pipeline.
****

Before final acceptance of the installation, interference tests shall be made with respect to any foreign [pipes] [tanks] in cooperation with the owner of the foreign [pipes] [tanks]. A full report of the tests giving all details shall be made. Stray current measurements shall be performed at all isolating locations and at locations where the new pipeline crosses foreign metallic pipes. The method of measurements and locations of measurements shall be submitted for approval. As a minimum, stray current measurements shall be performed at the following locations:

a. Connection point of new pipeline to existing pipeline.

b. Crossing points of new pipeline with existing lines.

Results of stray current measurements shall also be submitted for approval.

3.5.5.5 Holiday Test

Any damage to the protective covering during transit and handling shall be repaired before installation. After field-coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current in accordance with NACE RP0188 using a full-ring, spring-type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Holidays in the protective covering shall be repaired upon detection. Occasional checks of holiday detector potential will be made by the Contracting Officer to determine suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection shall be furnished by the Contractor. The coating system shall be inspected for holes, voids, cracks, and other damage during installation.

3.5.5.6 Recording Measurements

All [pipe-][tank-][_____]to-soil potential measurements, including initial potentials where required, shall be recorded. The Contractor shall locate, correct and report to the Contracting Officer any short circuits to foreign [pipes] [tanks] [_____] encountered during checkout of the installed cathodic protection system. [Pipe-][Tank-][_____]to-soil potential measurements shall be taken on as many [pipes] [tanks] [_____] as necessary to determine the extent of protection or to locate short-circuits.

3.6 TRAINING COURSE

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of [4] [8] [_____] hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations, including testing procedures included in the maintenance instructions. At least 14 days prior to date of proposed conduction of the training course, the training course curriculum shall be submitted for approval, along with the proposed training date. Training shall consist of demonstration of test equipment, providing forms for test data and the tolerances which indicate that the system works.

3.7 CLEANUP

The Contractor shall be responsible for cleanup of the construction site. All paper bags, wire clippings, etc., shall be disposed of as directed. Paper bags, wire clippings and other waste shall not be put in bell holes or anodes excavation.

3.8 MISCELLANEOUS INSTALLATION AND TESTING

3.8.1 Coatings

All aboveground pipeline shall be coated as indicated or as approved. The coating shall have a minimum thickness of 7 mil. The pipeline coating shall be in accordance with all applicable Federal, State, and local regulations.

3.8.2 Excavation

In the event rock is encountered in providing the required depth for anodes, the Contractor shall determine an alternate approved location and, if the depth is still not provided, an alternate plan shall be submitted to the Contracting Officer. Alternate techniques and depths must be approved prior to implementation.

3.9 SPARE PARTS

After approval of shop drawings, and not later than three (3) months prior to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts, special tools, and supplies, with current unit prices and source of supply. In addition, the Contractor shall supply information for material and equipment replacement for all other components of the complete system, including anodes, cables, splice kits and connectors, corrosion test stations, and any other components not listed above. [The Contractor shall furnish a reference cell on a reel with 350 feet of conductor, along with other accessories, and a digital voltmeter that can be used in the maintenance of this cathodic protection system. Use of this equipment shall be demonstrated in actual tests during the training course, which shall include a description of the the equipment and measurement of the pipe-to-soil potential, rainfall, and gas company voltages.]

3.10 SEEDING

Seeding shall be done by the Contractor, as directed, in all unsurfaced locations disturbed by this construction. In areas where grass cover exists, it is possible that sod can be carefully removed, watered, and stored during construction operations, and replaced after the operations are completed since it is estimated that no section of pipeline should remain uncovered for more than two (2) days. The use of sod in lieu of seeding shall require approval by the Contracting Officer.

3.11 SYSTEM TESTING

The Contractor shall submit a report including potential measurements taken at adequately-close intervals to establish that minus 850 millivolts potential, "instant-off" potential, is provided, and that the cathodic protection is not providing interference to other foreign pipes causing damage to paint or pipes. The report shall provide a narrative describing how the criteria of protection is achieved without damaging other pipe or structures in the area.

3.12 CLEARING OF TREES AND UNDERBRUSH

In the areas of the anode beds, all trees and underbrush shall be cleared and grubbed to the limits shown or indicated.

-- End of Section --

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SECTION 13112

CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)
11/98

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NOTE: This guide specification covers the requirements for a cathodic protection system using impressed current anodes. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is aailable at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C80.1	(1995) Rigid Steel Conduit - Zinc Coated
ANSI C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM B 418	(1995a) Cast and Wrought Galvanic Zinc Anodes
ASTM B 843	(1996) Magnesium Alloy Anodes for Cathodic Protection
ASTM D 1248	(1984; R 1989) Polyethylene Plastics Molding and Extrusion Materials

CODE OF FEDERAL REGULATIONS

40 CFR 280	Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Fuel Storage Tanks (UST)
49 CFR 192	Transportation of Natural and other Gas by Pipeline: Minimum Federal Safety Standards
49 CFR 195	Transportation of Hazardous Liquids by Pipeline

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std. 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)

NACE INTERNATIONAL (NACE)

NACE RP0169	(1996) Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE RP0188	(1990) Discontinuity (Holiday) Testing of Protective Coatings
NACE RP0193	(1993) External Cathodic Protection of On-Grade Metallic Storage Tank Bottoms
NACE RP0285	(1995) Corrosion Control of Underground Storage Tank Systems by Cathodic Protection
NACE RP0572	(1995) Design, Installation, Operation, and Maintenance of Impressed Current Deep Groundbeds

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA TC 2	(1990) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)

NEMA WC 5	(1992; Rev 1) Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996; Errata 96-4) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1997) Rigid Metal Conduit
UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 506	(1994; Rev Oct 1997) Specialty Transformers
UL 510	(1994;Rev thru Nov 1997) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 514A	(1996; Rev Jul 1998) Metallic Outlet Boxes

1.2 GENERAL REQUIREMENTS

A complete, operating impressed current cathodic protection system in accordance with NFPA 70, the applicable federal, state and local regulations, and the requirements of this contract shall be provided. In addition to the minimum requirements of these specifications, [construction of gas pipelines and associated cathodic protection systems shall be in compliance with 49 CFR 192] [and] [construction of hazardous liquid pipelines, and associated cathodic protection system shall be in compliance with 49 CFR 195] [and] [construction and installation of underground fuel storage tanks and associated cathodic protection system shall be in compliance with 40 CFR 280]. The system shall include planning, inspecting the installation, adjusting and testing cathodic protection and test system using rectifiers and impressed current anodes, supplemented with sacrificial anodes as needed, for utilities and equipment shown. The cathodic protection system shall also include cables, connectors, splices, corrosion protection test stations, ace power panels, and any other equipment required for a complete operating system providing the specified protection. The cathodic protection system shall include (a) calculations for rectifier, anodes, and any recommendations for supplementing or changing the minimum design criteria to provide the specified potentials and (b) equipment, wiring, and wiring devices necessary to produce a continuous flow of direct current from anodes in the soil electrolyte to the pipe surfaces. The installation shall meet the specified protection criteria for a 25 year life.

1.2.1 Contractor's Modifications

The specified system is based on an impressed current system supplemented with magnesium anodes. The Contractor may modify the cathodic protection system after review of the project, site verification and analysis if the proposed modifications include the impressed current anodes and rectifiers and will provide better overall system performance. The modifications shall be fully described, shall be approved by the Contracting Officer and shall meet the following criteria. The proposed system shall achieve a minimum pipe-to-soil "Instant Off" potential of minus 850 millivolts with reference to a saturated copper-copper sulfate reference cell on the underground metallic components of the [piping] [tanks] [_____]. The Contractor shall take resistivity measurements of the soil in the vicinity of the [pipes] [tanks] [_____] and ground bed sites; based upon the measurements taken, the current and voltage of the rectifier shall be adjusted as required to produce a minimum of minus 850 millivolts "Instant Off" potential between the structure being tested and the reference cell. This potential shall be obtained over 95 percent of the metallic area without the "Instant Off" potential exceeding 1200 millivolts.

1.2.2 Isolators

Isolators are required to isolate the indicated pipes from any other structure. Isolators shall be provided with lightning protection and a test station as shown.

1.2.3 Anodes and Bond Wires

Anodes shall be installed in sufficient number and of the required type, size and spacing to obtain a uniform current distribution of 2.5 milliamperes per square foot minimum to underground metal surfaces. For each cathodic protection system, the metallic components and structures to be protected shall be made electrically continuous. This shall be accomplished by installing bond wires between the various structures. Bonding of existing buried structures may also be required to preclude detrimental stray current effects and safety hazards. Provisions shall be included to return stray current to its source without damaging structures intercepting the stray current. The electrical isolation of underground facilities in accordance with acceptable industry practice shall be included under this section.

1.2.4 Surge Protection

Approved zinc grounding cells or sealed weatherproof lightning arrestor devices shall be installed across insulated flanges or fittings installed in underground piping as indicated on the drawings. The arrestor shall be gapless, self-healing, solid state type. Zinc anode composition shall conform to ASTM B 418, Type II. Lead wires shall be number 6 AWG copper with high molecular weight polyethylene (HMWPE) insulation. The zinc grounding cells shall not be prepackaged in backfill but shall be installed as detailed on the drawings. Lightning arrestors or zinc grounding cells are not required for insulated flanges on metallic components used on nonmetallic piping systems.

1.2.5 Sacrificial Anodes

Sacrificial high potential magnesium anodes shall be located as required to provide localized cathodic protection or supplemental cathodic protection for the impressed current system. Each sacrificial magnesium anode shall be routed through a test station. The magnesium anode shall not be connected to the pipe.

1.2.6 Nonmetallic Pipe Systems

When nonmetallic pipe is approved, direct buried or submerged metallic components of the pipe system shall have cathodic protection. Metallic components are connectors, tees, fire hydrants, valves, short pipes, elbows, tie rods, or other metallic equipment. As a minimum, each metallic component shall be protected with a 9 lb magnesium anode connected through a test station. The use of nonmetallic pipe does not change other requirements of the specifications such as submittals, testing, or design calculations for each metallic component. Deviations due to the use of nonmetallic pipe shall be approved by the Contracting Officer.

1.2.6.1 Coatings

Coatings for metallic components shall be as required for metallic fittings. Protective covering (coating and taping) shall be completed and tested on each metallic component and shall be as required for underground metallic pipe.

1.2.6.2 Tracer Wire

When a nonmetallic pipe line is used to extend or add to an existing metallic line, an insulated No. 8 AWG copper wire shall be connected to a terminal in a test station located at each point of transition from metallic pipe to nonmetallic pipe. At each of these test stations, the tracer wire terminal shall be strapped or bonded to the terminal for the negative connection wire to the existing metallic line. The tracer wire shall be run the length of the new nonmetallic line. This wire shall be used as a locator tracer wire and to maintain continuity to any future extension of the pipe line.

1.2.7 Services of "Corrosion Expert"

The Contractor shall obtain the services of a "corrosion expert" to supervise, inspect, and test the installation and performance of the cathodic protection system. "Corrosion expert" refers to a person, who, by reason of thorough knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control of buried metallic piping and tank systems. Such a person must be accredited or certified by the National Association of Corrosion Engineers (NACE) as a NACE Accredited Corrosion Specialist or a NACE certified Cathodic Protection (CP) Specialist or be a registered professional engineer who has certification or licensing that includes education and experience in corrosion control of buried or submerged metallic piping and tank systems, if such certification or licensing includes 5 years experience in corrosion control on underground metallic surfaces of the type under this contract. The "corrosion expert" shall make at least 3 visits to the project site. The first of these visits shall include obtaining soil resistivity data, acknowledging the type of pipeline coatings to be used and reporting to the Contractor the type of cathodic protection required. Once the submittals are approved and the materials delivered, the "corrosion expert" shall revisit the site to ensure the Contractor understands installation practices and laying out the components. The third visit shall involve testing the installed cathodic protection systems and training applicable personnel on proper maintenance techniques. The "corrosion expert" shall supervise installation and testing of all cathodic protection.

1.3 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary

factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Materials and Equipment GA.

Within [30] [45] [_____] days after receipt of notice to proceed, an itemized list of equipment and materials including item number, quantity, and manufacturer of each item. The list shall be accompanied by a description of procedures for each type of testing and adjustment, including testing of coating for thickness and holidays. Installation of materials and equipment shall not commence until this submittal is approved.

Spare Parts; [_____].

Spare parts data for each different item of material and equipment specified, after approval of detail drawings and not later than [_____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts, special tools, and supplies, with current unit prices and source of supply. One spare anode of each type shall be furnished.

SD-04 Drawings

Cathodic Protection System; GA.

[Six] [_____] copies of detail drawings consisting of a complete list of equipment and material including manufacturer's descriptive and technical literature, catalog cuts, results of system design calculations including soil resistivity, installation instructions and certified test data stating the maximum recommended anode current output density and the rate of gaseous production, if any, at that current density. Detail drawings shall contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will function properly as a unit.

Contractor's Modifications; GA.

[Six] [_____] copies of detail drawings showing proposed changes in location, scope or performance indicating any variations from, additions to, or clarifications of contract drawings. The drawings shall show proposed changes in anode arrangement, anode size and number, anode materials and layout details, conduit size, wire size, mounting details, wiring diagram, method for electrically isolating each pipe, and any other pertinent information to the proper installation and performance of the system.

SD-08 Statements

Services of "Corrosion Expert"; GA.

Evidence of qualifications of the "corrosion expert."

(a) The "corrosion expert's" name and qualifications shall be certified in writing to the Contracting Officer prior to the start of construction.

(b) Certification shall be submitted giving the name of the firm, the number of years of experience, and a list of not less than five (5) of the firm's installations three (3) or more years old that have been tested and found satisfactory.

SD-09 Reports

Tests and Measurements; [_____].

Test reports in booklet form tabulating field tests and measurements performed, upon completion and testing of the installed system and including close interval potential survey, casing and interference tests, final system test verifying protection, insulated joint and bond tests, and holiday coating test. Each test report shall indicate the final position of controls. A certified test report showing that the connecting method has passed a 120-day laboratory test without failure at the place of connection, wherein the anode is subjected to maximum recommended current output while immersed in a 3 percent sodium chloride solution.

Contractor's Modifications; GA.

Final report regarding supplemental magnesium anode installation. The report shall include pipe-to-soil measurements throughout the affected area, indicating that the additions corrected the conditions which made the additional anodes necessary, and current measurements for the additional anodes. The following special materials and information are required: Calculations on current and voltage for [100 V] [40 V] [_____] rectifier plus rectifier and meter specifications; taping materials and conductors; zinc grounding cell, installation and testing procedures, and equipment; coating material; system design calculations for rectifier, anode number, life, and parameters to achieve protective potential; backfill shield material and installation details showing waterproofing; bonding and waterproofing details; insulated resistance wire; exothermic weld equipment and material.

SD-13 Certificates

Cathodic Protection System; [_____].

Proof that the materials and equipment furnished under this section conform to the specified requirements contained in the referenced standards or publications. The label or listing by the specified agency will be acceptable evidence of such compliance.

SD-18 Records

Training Course; [_____].

The proposed Training Course Curriculum (including topics and dates of discussion) indicating that all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations, including testing procedures included in the maintenance instructions, are to be covered.

SD-19 Operation and Maintenance Manuals

Cathodic Protection System; [_____].

[Six] [_____] copies of operating manual outlining the step-by-step procedures required for system startup, operation, adjustment of current flow, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. [Six] [_____] copies of maintenance manual listing routine maintenance procedures, recommendation for maintenance testing, possible breakdowns and repairs, and troubleshooting guides. The manuals shall include single line diagrams for the system as installed; instructions in making [pipe-] [tank-] to-reference cell potential measurements and frequency of monitoring; instructions for dielectric connections, interference and sacrificial anode bonds; instructions shall include precautions to ensure safe conditions during repair of pipe system.

PART 2 PRODUCTS

2.1 IMPRESSED CURRENT ANODES

2.1.1 Bare High Silicon Cast-Iron Anodes

Cast-iron anodes shall be of the size indicated and shall conform to the following requirements:

2.1.1.1 Chemical Composition (Nominal)

Element	Percent by Weight Grade 2
Silicon	14.20-14.75
Manganese	1.50 Max.
Carbon	0.75-1.15
Chromium	3.25-5.00
Iron	Balance

2.1.1.2 Electrical Resistivity

Seventy-two microhm-centimeter at 20 degrees F.

2.1.1.3 Physical Properties (Nominal)

Tensile strength	15,000 psi
Compressive strength	100,000 psi
Brinell hardness	520
Density	7.0 grams per cubic centimeter
Melting point	2300 degrees F
Coefficient of expansion from 32 to 212 degrees F	0.00000733 centimeter per degree F

2.1.2 Bare Graphite Anodes

Bare graphite anodes shall have a maximum electrical resistivity of 0.0011 ohm-centimeter.

2.1.3 Canister Contained Anodes

Canister contained anodes shall be packed at the factory in sheet metal canisters with calcined petroleum coke breeze. The coke shall have a resistivity of 0.1 ohm-cm tested at 150 psi. The coke shall be 70 lbs/cubic foot or greater. The maximum particle size shall be 0.039 inches and the coke shall be dust-free. The canisters shall be capped with tight fitting end caps secured to the body of the canister. The canister shall provide a minimum annular space of 3 inches all around the anode. The connecting cable shall pass through a hole in an end cap designed to be tight fitting with the cable and protected from sharp edges with a plastic or rubber grommet. The anodes shall be centered in the canisters and the annular space filled with coke breeze compacted in place.

2.1.4 Anode Connecting Cables

Anodes shall have connecting cables installed at the factory. For deep ground beds, each anode located in the borehole shall be accompanied by a reel of continuous cable having the length indicated. No spliced connections will be permitted in deep well cables.

2.1.5 Mixed Metal Oxide Anodes

Mixed metal oxide anodes shall be of the size indicated and shall conform to the following requirements.

2.1.5.1 Conductive Material

The electrically conductive coating shall contain a mixture consisting primarily of iridium, tantalum, and titanium oxides. The average composition is generally a 50/50 atomic percent mixture of iridium and titanium oxides, with a small amount of tantalum. The resistivity, as tested by the manufacturer, shall be no more than 0.002 ohm-centimeter, and the bond strength shall be greater than 7.25 ksi to guarantee the current capacity life and the quality of the conductive ceramic coating. The adhesion or bond strength shall be determined by epoxy bonding a 0.1 inch diameter stud to the ceramic coating and measuring the load to failure (about 10.15 ksi) of either the epoxy or the interface between the coating and the substrate. The anode must be inert and the electrically conductive ceramic coating dimensionally stable. The ceramic coated anode shall be capable of sustaining a current density of 100 ampere per 10.764 square feet in an oxygen generating electrolyte at 150 degrees F for 20 years, to ensure the current capacity life. An accelerated current capacity life test shall be performed by the manufacturer on every lot of anode wire used to construct the anode as described. The mixed metal oxide coating shall be applied to the wire anode by a firm that is regularly engaged in and has a minimum 5 years experience in manufacturing and applying mixed metal oxide coatings to titanium anode substrates. The mixed metal oxide must be sintered to the titanium surface as to remain tightly bound to the surface when bent 180 degrees onto itself.

2.1.5.2 Anode Life Test

The anode wire material shall sustain current densities of 100 ampere per

10.764 square feet in an oxygen generating electrolyte for 20 years. The manufacturer shall certify that a representative sample taken from the same lot used to construct the anode, has been tested and meets the following criteria. The test cell sustains a current density of 10,000 ampere per 10.764 square feet in a 15 weight percent sulfuric acid electrolyte at 150 degrees F without an increase in anode to cathode potential of more than 1 volt. The cell containing the anode shall be powered with a constant current power supply for the 30 day test period. The representative sample shall be 5 inch in length taken from the lot of wire that is to be used for the anode.

2.1.5.3 Canister Contained Mixed Metal Oxide Anodes

Canister contained mixed metal oxide anodes shall be packed at the factory in light weight, light gauge steel uni-body TIG welded canisters with calcinated petroleum coke breeze. The canisters shall be capped with TIG welded steel and caps providing a totally encapsulated construction. The connecting cable shall pass through a hole in an end cap designed to be tight fitting with a heavy duty strain relief allowing for handling of the canister by the cable. The anode shall be centered in the canister by centralizers to maintain rod position.

2.1.5.4 Anode Connecting Cables

Anodes shall have connecting cables installed at the factory. The connection between the anode rod or ribbon and the lead wire shall be made with a solid crimp couple with solder. The connection shall be sealed in cast epoxy.

2.1.5.5 Canister Connection Cables

Canister connecting cables shall consist of an ultra low resistance solder connection which is a minimum of three times stronger than the cable. For ceramic coated canister anodes, the cable connection shall consist of two molded dielectric layers (pressure seals), a flexible backfill resin encapsulant stabilizer, a schedule 40 PVC pipe Type 1 seal, and Type 1 PVC pipe end plugs. The seals and end plugs shall resist chlorine gas and acid.

2.1.5.6 Deep Anode Connection Cables

For deep anode beds, each anode located in the borehole shall be accompanied by a reel of continuous cable having the length indicated. For deep ceramic coated anode beds, anode connecting cables shall have molded multiseal solder connections; splices will not be permitted. Chlorine gas resistant cable and shield shall be used for chlorine environments.

2.2 RECTIFIERS AND ASSOCIATED EQUIPMENT

2.2.1 Rectifier Unit

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NOTE: Air-cooled rectifiers will be used for most applications. Where highly corrosive atmospheres exist, the equipment will be oil-immersed in a tank-type housing. For hazardous area applications, oil-immersed equipment will be provided with an explosion-proof or dust-ignition-proof housing, as appropriate. Transformer tap adjusters will be provided in cases where an automatic system is not

provided.
****

Rectifier unit shall consist of a transformer, rectifying elements, transformer tap adjuster, terminal block, [one dc output voltmeter, one dc output ammeter,] [one combination volt-ammeter,] one toggle switch for each meter, fuse holders with fuses for each dc circuit, variable resistors, an ac power-supply circuit breaker, lightning arresters for both input and output, all wired and assembled in a weatherproof cabinet. The overall efficiency of the rectifier shall be not less than 65 percent when operated at nameplate rating and shall be capable of supplying continuous full rated output at an ambient temperature of 112 degrees F in full sunlight with expected life in excess of 10 years.

2.2.1.1 Transformer

Transformer shall conform to UL 506.

2.2.1.2 Rectifiers

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NOTE: Below about 500 volt-amperes of dc rating output, single phase selenium rectifiers cost less to acquire and operate than silicon rectifiers. Above 1000 volt-amperes silicon rectifiers are more economical for both single phase and three phase. Silicon rectifiers are more economical to repair.
****

Rectifying elements shall be [silicon diodes] [selenium cells] connected to provide full-wave rectification. Silicon diodes shall be protected by selenium surge cells or varistors against over-voltage surges and by current-limiting devices against over-current surges.

2.2.1.3 Meters

Meters shall be accurate to within plus or minus 2 percent of full scale at 80 degrees F, and shall possess temperature stability above and below 80 degrees F and shall possess temperature stability above and below 80 degrees F of at least 1 percent per 10 degrees F. Separate meters shall be 2-1/2 inch nominal size or larger.

2.2.1.4 Circuit Breaker

A [single] [double] [three]-pole, flush-mounted, fully magnetic, properly rated non-terminal type circuit breaker shall be installed in the primary circuit of the rectifier supply transformer.

2.2.1.5 Fuses

Cartridge-type fuses with suitable fuse holders shall be provided in each leg of the dc circuit.

2.2.2 Cabinet Construction

Cabinet shall be constructed of [not lighter than No. 16 gauge [steel] [hot dipped galvanized steel] [stainless steel] [aluminum]] [molded fiberglass reinforced polyester], and shall be provided with a full door. The enclosure shall have oil-resistant gasket. The door shall be hinged and have a hasp that will permit the use of a padlock. The cabinet shall be fitted with screened openings of the proper size to provide for adequate cooling. Holes, conduit knockouts, or threaded hubs of sufficient size and number shall be conveniently located.

2.2.2.1   Wiring Diagram

A complete wiring diagram of the power unit showing both the ac supply and the dc connections to anodes shall be on the inside of the cabinet door. All components shall be shown and labeled.

2.2.2.2   Grounding Provisions

Grounding provisions shall [be as specified in SECTION 16415, ELECTRICAL WORK, INTERIOR.] [comply with NFPA 70 and UL 467 including a ground terminal in the cabinet.] The grounding conductor from the terminal to the earth grounding system shall be solid or stranded copper not smaller than No. 6 AWG. The earth grounding system shall consist of one or more ground rods. Ground rods shall be of [copper-clad steel conforming to UL 467] [zinc-coated steel conforming to ANSI C135.30] [solid stainless steel] not less than [5/8] [3/4] inch in diameter by [8] [10] feet in length. Rods shall be driven full length into the earth. Sectional type rods may be used.

2.2.2.3   Resistance to Ground

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NOTE: Remove this paragraph if not required in the project.
****

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std. 81. The maximum resistance of driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, [_____] additional rods not less than 6 feet on centers, or if sectional type rods are used, [_____] additional sections may be coupled and driven with the first rod. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

2.2.2.4   Cabinet Paint System

[The cabinet and mounting support shall be [painted] [hot dipped galvanized] [aluminum] [stainless steel] with the manufacturer's standard painting system.] [The mounting support for the fiberglass cabinet shall be [painted] [hot dipped galvanized] [aluminum] [stainless steel] with the manufacturer's standard painting system.]

2.2.3   Wiring

Wiring shall be installed in accordance with NFPA 70 utilizing type TW or RHW or polyethylene insulation. Fittings for conduit and cable work shall conform to UL 514A. Outlets shall be of the threaded hub type with gasketed covers. Conduit shall be hub type with gasketed covers. Conduit shall be securely fastened at 8 foot intervals or less. Splices shall be made in outlet fittings only. Conductors shall be color coded for identification. Cable for anode header and distribution shall be No. [2] [_____] AWG stranded copper wire with type [cathodic protection high molecular weight polyethylene] [Dular/Halar] insulation.

2.2.4 Oil Immersed Enclosures

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NOTE: The enclosure should not be used in areas prone to flooding unless required for hazardous locations. Provisions should be made for flooding.

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Enclosures shall be of 11 gauge steel or heavier, with an accessible drain plug. The oil level shall be clearly marked. The lid shall be hinged and have quick release clamps to secure it in closed position. A stop shall limit the swing of the lid when opened. A compressible, oil resistant, positive sealing gasket shall be provided. The gasket shall return to its original shape upon release of lid pressure. The gasket shall be attached to the tank or lid and joints shall be free of gaps. Base mounting using 4 inch high channels shall be provided. Conduits entering the enclosure shall be internally sealed and shall enter or exit above the oil fill line.

2.3 COKE BREEZE

2.3.1 Calcined Petroleum Coke Breeze (Dry)

Breeze shall conform to the following requirements:

2.3.1.1 Electrical Resistivity

Resistivity shall not exceed 1 milliohm-meter (0.1 ohm-cm) Great Lake Carbon C 12 A Test Method.

2.3.1.2 General Backfill Specifications

Bulk Density - 65 to 75 lbs/cubic foot
Fixed Carbon - 99.0% or greater
Volatiles - 0.2% or less
Sizing - 100% less than 1/2 inch

2.3.2 Metallurgical Coke Breeze (Processed)

Breeze shall conform to the following requirements:

2.3.2.1 Electrical Resistivity (Nominal)

Nominal electrical resistivity shall be:

a. 100 milliohm-meter (10 ohm-centimeter) Max., tightly compacted.

b. 100 milliohm-meter to 150 milliohm-meter, (10 to 15 ohm-centimeter,) lightly compacted.

c. 150 to 200 milliohm-meter, (15 to 20 ohm-centimeter,) loose.

2.3.2.2 General Backfill Specifications

Bulk density - 38 to 42 pounds per cubic foot

Fixed Carbon - 80% or greater
Sizing - 100% less than 3/8 inch

2.4 MISCELLANEOUS MATERIALS

2.4.1 Electrical Wire

2.4.1.1 Anode Connecting Wire

****

NOTE: Any pinhole, cut, scratch or other damage to the anode cable exposing bare copper to the electrolyte will result in early failure of the cathodic protection system. For this reason, special, extra heavy insulation is used on anode cable. While it is often expedient to use the same type wire for the cathodic (negative) cable in order to avoid a mix-up in the field, the cathode cable is not subject to anodic failure and lesser insulation can be used.

****

Anode connecting wire shall be No. [8] [_____] AWG stranded copper wire with type CP high molecular weight polyethylene insulation, 7/64 inch thick, 600 volt rating, in accordance with NEMA WC 5. Cable-to-anode contact resistance shall be 0.003 ohms maximum. Deep anode ground bed connecting wire shall be No. 8 AWG, stranded copper wire with an inner jacket of 40 mils of Halar insulation covered by an outer jacket of 65 mils CP high molecular weight polyethylene insulation, 600 volt rating, in accordance with NEMA WC 5. Cable-to-anode contact resistance shall be 0.02 ohms maximum.

2.4.1.2 Anode Header Cable

Cable for anode header and distribution shall be No. [_____] AWG stranded copper wire with type [CP high molecular weight polyethylene,7/64 inch thick insulation] [HMWPE protective jacketed cable with a fluorocopolymer inner or primary insulation], 600-volt rating, in accordance with NEMA WC 5.

****

NOTE: The double insulated fluorocopolymer cable is intended for use in very harsh environments such as deep anode bed installations where clorine and hydrogen gases are generated. This cable can be installed directly in soil or submerged in fresh, brackish, or salt waters. The CP high molecular weight polyethylene cable is also a direct buried and submergible type cable suitable for harsh environments, but not as quiet as durable as the double insulated cable would be in the toughest of environments.

****

2.4.1.3 Test Wires

Test wires shall be No. 12 AWG stranded copper wire with NFPA 70 Type TW or RHW or polyethylene insulation.

2.4.1.4 Resistance Wire

Resistance wire shall be AWG No. [16 or No. 22] [_____] nickel-chromium wire.

2.4.2 Deep Anode Ground Bed Casing

****

NOTE: A metal casing should not be used except for a maximum of 1.5 meter (5 feet) at the top for a well cap which also serves as a support for the suspension ropes. The drilling mud on the sides of the hole will usually keep the hole open until the anodes and coke breeze are installed. If a casing must be used, it should be fiberglass reinforced plastic (nonmetallic) and should be located above the anode string.

****

Casing shall be [_____] inch outside diameter, 1/8 inch minimum wall thickness black steel pipe, conforming to ASTM A 53, Type E or S, Grade B. The top casing shall be [_____] inch outside diameter, 1/8 inch minimum wall thickness black steel pipe, conforming to ASTM A 53, Type E or S, Grade B. The metal casing shall extend no more than [5] [_____] feet below the top of a well cap.

2.4.3 Anode Centering Device for Deep Anode Ground Beds

Anode centering device shall be nonmetallic and capable of maintaining centering in the hole without interfering with other anode lead wiring, until coke breeze is packed in place.

2.4.4 Conduit

Nonmetallic conduit shall conform to NEMA TC 2.

2.4.5 Test Boxes and Junction Boxes

Boxes shall be outdoor type conforming to UL 514A.

2.4.6 Vent Pipes

All deep wells shall be vented in anode zones. Openings in the vent shall not be larger than .006 inches.

2.4.7 Polyethylene Insulation

Polyethylene insulation shall comply with the requirements of ASTM D 1248 and of the following types, classes, and grades:

2.4.7.1 High Molecular Weight Polyethylene

High molecular weight polyethylene shall be Type I, Class C, Grade E5.

2.4.7.2 High Density Polyethylene

High density polyethylene shall be Type III, Class C, Grade E3.

2.4.8 Test Stations

Test stations shall be complete with an insulated terminal block having the indicated number of terminals and shall be provided with a lockable cover and have a cast-in legend, "C.P. Test". Test stations shall be complete with an insulated terminal block having the required number of terminals. (One terminal required for each conductor). Sufficient test stations to monitor underground isolation points shall be provided. Test-bond stations (potential measurement and stray current control) shall be provided to monitor pipe to soil potential of proposed underground pipes or existing underground metallic structures which may conduct stray current from the new cathodic protection system. The location of the test-bond stations shall ensure that the pipe to soil potential of metallic pipe not designated to be protected is not made less negative by the energization of the cathodic protection system. Test station terminal connections and the terminal conductor shall be permanently tagged to identify each termination of the conductors (e.g. identify the conductors connected to the protected structures). Conductors shall be permanently identified in the station by means of plastic or metal tags, or plastic sleeves to indicate termination. Each conductor shall be color coded in accordance with the drawings. The station test facility, including permanent Cu-Cu S04 reference cells and test returns shall be installed as indicated. Pavement inserts shall be nonmetallic and shall allow Cu-Cu S04 reference electrode to contact the electrolyte beneath the pavement surface. Abbreviations shall not be used. Welding of electrical connections shall be as follows: Exothermic welds shall be "CADweld", "Thermo-weld", or approved equal. Use and selection of these materials and welding equipment shall be in accordance with the manufacturer's recommendations.

2.4.9 Calibrated Shunts

Shunts calibrated in current per potential (e.g. mA/V) shall be installed between the lead or header wire connected to the anode and the current collector lead connected to the structure. The calibration of the shunt shall be clearly marked and installed to be visible.

2.4.10 Sealing and Dielectric Compound

Sealing and dielectric compound shall be a black, rubber based compound that is soft, permanently pliable, tacky, moldable, and unbacked. Compound shall be applied as recommended by the manufacturer, but not less than 1/8 inch thick.

2.4.11 Protective Covering

Except as otherwise specified, protective covering for underground metallic components including pipe and fittings shall be applied mechanically in a factory or field plant specially equipped for the purpose. Valves and fittings that cannot be coated and wrapped mechanically shall have the protective covering applied by hand, preferably at the plant applying the covering to the pipe. Joints shall be coated and wrapped by hand. Hand coating and wrapping shall produce a covering equal in thickness to the covering applied mechanically. Piping and components installed in valve boxes or manholes shall also receive the specified protective coating.

2.4.11.1 Pipeline Metallic Components

Underground metallic pipelines and structures shall have a good quality factory applied coating. This includes carbon steel, cast iron and ductile iron pipelines or vessels. If nonmetallic pipelines are installed, metallic fittings or pipe sections shall be coated as follows.

a. The nominal thickness of the metallic pipe joint or other component coating shall be [8] [16] [24] [40] [60] [_____] mils, plus or minus 5 percent.

b. Pipe and joint coating for factory applied or field repair material shall be applied as recommended by the manufacturer and shall be one of the following:

(1) Continuously extruded polyethylene and adhesive coating system.

(2) Polyvinyl chloride pressure-sensitive adhesive tape.

(3) High density polyethylene/bituminous rubber compound tape.

(4) Butyl rubber tape.

(5) Coal tar epoxy.

2.4.11.2 Field Joints

Field joints shall be coated with material compatible with the pipeline coating compound. The joint coating material shall be applied to an equal thickness as the pipeline coating. Unbonded coatings shall not be used on buried metallic piping. This prohibition includes unbonded polymer wraps or tubes.

2.4.11.3 Inspection of Pipe Coatings

Once the pipeline or vessel is set in the trench, an inspection of the coating shall be conducted. This inspection shall include electrical holiday detection as described in paragraph TESTS AND MEASUREMENTS.

2.4.11.4 Above Ground Piping System

Above ground piping shall be given two coats of exterior oil paint. Surface preparation shall be as recommended by paint manufacturer, except as follows: ferrous, shop primed surfaces shall be touched up with ferrous metal primer; surfaces that have not been shop primed shall be solvent cleaned; surfaces that contain loose rust, mil scale, or other foreign substances shall be mechanically cleaned by power wire brushing and primed with ferrous metal primer; and primed surfaces shall be finished with two coats of exterior oil paint or vinyl paint.

2.4.12 Preformed Sheaths

Preformed sheaths for encapsulating electrical wire splices to be buried underground shall fit the insulated wires entering the spliced joint.

2.4.13 Epoxy Potting Compound

Epoxy potting compound for encapsulating electrical wire splices to be buried underground shall be a two package system made for the purpose.

2.4.14 Backfill Shields

Backfill shields shall consist of approved pipeline wrapping or fiberglass reinforced, coal-tar impregnated tape, or plastic weld caps, specifically made for the purpose.

2.4.15 Electrical Tape

Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

2.4.16 Cable Marker Tape

Traceable marker tape shall be manufactured for the purpose and clearly labeled "Cathodic Protection Cable Buried Below".

2.4.17 Electrically Isolating Pipe Joints

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NOTE: The cathodic protection system will fail unless full consideration is given to specifications for electrically isolating pipe joints, electrically conductive pipe joints, and casing cradles and seals. Mechanical and electrical specifications should reference this paragraph and paragraph "Electrically Conductive Couplings."

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Electrically isolating pipe joints for above or below ground use shall be [flexible, mechanical pipe couplings of an electrically isolating type consisting of bolted or compression design provided with electrically isolating joint harness if required to provide pull-out strength] [flexible, integral electrically isolating pipe couplings designed for field installation by means of a swaging system and providing pull-out strength with a factor of safety] [nonflexible flanged type electrically isolating pipe joints to be field assembled] [nonflexible factory assembled electrically isolating pipe joints designed with stub ends for installation by welding and providing pull-out strength with a factor of safety].

2.4.17.1 Threaded Fittings

Threaded type electrically isolating pipe joints shall have molded plastic screw threads and be used above ground only. Machined plastic screw threads shall not be used.

2.4.17.2 Electrically Isolating Pipe Joints

Electrically isolating pipe joints shall be of a type that is in regular factory production.

2.4.18 Electrically Conductive Couplings

Electrically conductive couplings shall be of a type that has a published maximum electrical resistance rating given in the manufacturer's literature. Cradles and seals shall be of a type that is in regular factory production made for the purpose of electrically isolating the carrier pipe from the casing and preventing the incursion of water into the annular space.

2.4.19 Joint and Continuity Bonds

Bonds shall be provided across joints or any electrically discontinuous connections in the piping, and other pipes and structures with other than welded or threaded joints included in this cathodic protection system. Unless otherwise specified, bonds between structures and across joints in pipe with other than welded or threaded joints shall be with No. 4 AWG stranded copper cable with polyethylene insulation. Bonds between structures shall contain sufficient slack for any anticipated movement between structures. Bonds across pipe joints shall contain a minimum of 4 inches of slack to allow for pipe movement and soil stress. Bonds shall be attached by exothermic welding. Exothermic weld areas shall be insulated with coating compound and approved by the Contracting Officer. Continuity bonds shall be installed as necessary to reduce stray current interference. Additional joint bonding shall be done where determined during construction or testing or as directed. Joint bonding shall include excavation and backfilling. There shall be a minimum of 2 continuity bonds between each structure and other than welded or threaded joints. Electrical continuity shall be tested across joints with other than welded or threaded joints and across metallic portions of sewage lift stations and water booster stations.

2.4.19.1 Resistance Bonds

Resistance bonds shall be adjusted for minimum interference while achieving the criteria of protection. Alternate methods may be used when approved.

2.4.19.2 Stray Current Measurements

Stray current measurements shall be performed as indicated. Alternate methods may be used when approved. The stray current test report shall indicate location of test, type of pipes tested, method of testing, [_____].

2.4.20 Electrical Isolation of Structures

Isolating fittings, including isolating flanges and couplings, shall be installed above ground or in a concrete hand hole. As a minimum, isolating flanges or unions shall be provided at the following locations:

a. Connection of new piping to existing pipes.

b. Pressure piping under floor slab to a building.

Additionally, isolation shall be provided between new pipe lines and foreign pipes that cross the new lines within 10 feet.

2.5 MAGNESIUM ANODES

Weights and dimensions of magnesium anodes shall be approximately as follows:

TYPICAL MAGNESIUM ANODE SIZES
(Cross sections may be round, square, or D shaped)

NOMINAL WT. LBS.	APPROX. SIZE (IN)	NOMINAL GROSS WT LBS PACKAGED IN BACKFILL	NOMINAL PACKAGE DIMENSIONS (IN)
3	3 X 3 X 5	8	5 1/4 X 5 1/4 X 8
5	3 X 3 X 8	13	5 1/4 X 5 1/4 X 11 1/4
9	3 X 3 X 14	27	5 1/4 X 20

TYPICAL MAGNESIUM ANODE SIZES
(Cross sections may be round, square, or D shaped)

NOMINAL WT. LBS.	APPROX. SIZE (IN)	NOMINAL GROSS WT LBS PACKAGED IN BACKFILL	NOMINAL PACKAGE DIMENSIONS (IN)
12	4 X 4 X 12	32	7 1/2 X 18
17	4 X 4 X 17	45	7 1/2 X 24
32	5 X 5 X 20 1/2	68	8 1/2 X 28
50	7 X 7 X 16	100	10 X 24

2.5.1 Composition

Anode shall be of high potential magnesium alloy, made of primary magnesium obtained from sea water or brine, and not from scrap metal. Magnesium anodes shall conform to ASTM B 843 and to the following analysis unless otherwise indicated:

Element	Percent by Weight
Aluminum	0.02 maximum
Manganese	1.50 maximum
Zinc	0.05
Silicon	0.10 maximum
Copper	0.02 maximum
Nickel	0.002 maximum
Iron	0.03 maximum
Impurities	0.30 maximum
Magnesium	Remainder

The Contractor shall furnish spectrographic analyses on samples from each heat or batch of anodes used on this project.

2.5.2 Packaged Anodes

Anodes shall be provided in packaged form with the anode surrounded by specially prepared quick-wetting backfill and contained in a cloth or paper sack. Anodes shall be centered in the backfill material. The backfill material shall have the following composition, unless otherwise indicated.

Material	Percent by Weight
Gypsum	75
Bentonite	20
Sodium Sulfate	5

2.5.3 Lead Wires

Anode lead wires shall consist of No. 10 solid copper wire, with TW insulation. Lead wires shall be not less than 10 feet in length, without splices.

2.5.4 Connection Wires

Wires shall consist of No. 10 solid copper wire with RHW-USE or polyethylene insulation.

2.5.5 Insulation

Type RHW-USE insulation shall comply with NFPA 70. Polyethylene insulation shall comply with ASTM D 1248; high molecular weight polyethylene shall be Type I, Class C, Grade E5; high density polyethylene shall be Type III, Class C, Grade E3.

2.5.6 Conduit Steel

Conduit steel shall conform to UL 6 and ANSI C80.1.

2.5.7 Tape

Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

2.5.8 Backfill Shields

Shields shall consist of approved wrapping of reinforced fiberglass coal-tar impregnated tape, or plastic weld caps specifically made for the purpose and installed in accordance with the manufacturer's recommendations. When joint bonds are required, due to the use of mechanical joints, the entire joint shall be protected with kraft paper joint cover. The joint cover shall be filled with poured hot coal-tar enamel.

2.5.9 Electrical Connections

Electrical connections shall be done as follows:

a. Exothermic welds shall be "Cadweld" or Burndy "Thermo-Weld" or approved equal. Use of these materials shall be in accordance with the manufacturer's recommendations.

b. Electrical shielded arc welds on steel pipe shall be approved via shop drawing action.

c. Other methods of welding shall be specifically approved for use by the pipe manufacturer.

2.5.10 Anode Storage

Storage for magnesium anodes will be designated by the Contracting Officer. If anodes are not stored in a building, they shall be protected from inclement weather. Packaged anodes damaged as result of improper handling or weather exposure shall be resacked by the Contractor and the required backfill added.

2.5.11 Anode Installation

Anode configuration and size shall be as indicated. A minimum of [one] [two] [three] [ten] [15] [_____] anodes are required to achieve minus 850 millivolts "instant off" potential and shall be required on the [_____] components or structure. Details shown are indicative of the general type of material required and are not intended to restrict selection of materials or of any particular manufacturer. The anode system shall be designed for a life of 25 years of continuous operation.

2.6 LEAD WIRE CONNECTIONS

Lead wire to structure connections shall be by exothermic welding process.

Weld charges made specifically for use on cast iron shall be used on cast iron pipe. A backfill shield filled with a pipeline mastic sealant or material compatible with the coating shall be placed over the weld connection and shall cover the exposed metal adequately.

PART 3 EXECUTION

3.1 CRITERIA OF PROTECTION

Acceptance criteria for determining the adequacy of protection on a buried [pipe] [tank] shall be in accordance with [NACE RP0169,] [and] [NACE RP0193 ,] [and] [NACE RP0285] and as specified below.

3.1.1 Iron and Steel

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NOTE: If the second method is used, the requirement for obtaining measurements over 95 percent of the entire metallic area is required as in the first method. Verification of the 100 millivolts decay of polarization should be achieved at points over 95 percent of the entire metallic area.

****

The following method a. shall be used for testing cathodic protection voltages. If more than one method is required, method b. shall be used:

a. A negative voltage of at least minus 850 millivolts as measured between the [pipe] [tank] [specified underground component] and a saturated copper-copper sulphate reference electrode contacting the (electrolyte) earth directly over the [pipe] [tank] [specified underground component]. Determination of this voltage shall be made with the cathodic protection system in operation. Voltage drops shall be considered for valid interpretation of this voltage measurement. A minimum of minus 850 millivolts "instant off" potential between the [structure] [pipe] [tank] [specified underground component] being tested and the reference cell shall be achieved over 95 percent of the area of the structure. Adequate number of measurements shall be obtained over the entire structure, pipe, tank, or other metallic component to verify and record achievement of minus 850 millivolts "instant off". This potential shall be obtained over 95 percent of the total metallic area without the "instant off" potential exceeding 1200 millivolts.

b. A minimum polarization voltage shift of 100 millivolts as measured between the [pipe] [tank] and a saturated copper-copper sulphate reference electrode contacting the earth directly over the [pipe] [tank]. This polarization voltage shift shall be determined by interrupting the protective current and measuring the polarization decay. When the protective current is interrupted, an immediate voltage shift will occur. The voltage reading, after the immediate shift, shall be used as the base reading from which to measure polarization decay. Measurements achieving 100 millivolts shall be made over 95 percent of the metallic surface.

3.1.2 Aluminum

Aluminum [pipes] [tanks] shall not be protected to a potential more negative than minus 1200 millivolts, measured between the [pipe] [tank] and a saturated copper-copper sulphate reference electrode contacting the earth, directly over the [pipe] [tank] [metallic component]. Resistance, if required, shall be inserted in the anode circuit within the test station to reduce the potential of the aluminum [pipe] [tank] to a value which will not exceed a potential more negative than minus 1200 millivolts. Voltage shift criterion shall be a minimum negative polarization shift of 100 millivolts measured between the [pipe] [tank] [metallic component] and a saturated copper-copper sulphate reference electrode contacting the earth, directly over the [pipe] [tank]. The polarization voltage shift shall be determined as outlined for iron and steel.

3.1.3 Copper Piping

For copper piping the following criteria shall apply. A minimum of 100 millivolts of cathodic polarization between the structure surface and a stable reference electrode contacting the electrolyte. The polarization voltage shift shall be determined as outlined for iron and steel.

3.2 GROUND BED INSTALLATION

3.2.1 Shallow Ground Beds

Shallow ground beds shall contain size and quantity of anodes designed to meet performance criteria of the cathodic protection system at an initial operating current output density not exceeding [40] [50] [70] percent of maximum recommended current output density.

3.2.1.1 Horizontally Buried Bare Anodes

Horizontally buried bare anodes shall be bedded on and covered with metallurgical coke breeze in a trench excavated for the purpose at depths, spacing and locations as shown. Anodes shall be completely surrounded by the backfill at bottom, sides, and top for a distance of not less than 4 inches. Backfill shall be compacted.

3.2.1.2 Vertically Buried Bare Anodes

Vertically buried bare anodes shall be installed in vertical holes in the ground having a depth, spacing, and location shown. The holes in the ground shall be sufficiently large to provide an annular space around the anode not less than 4 inches. The anodes shall be centered in the hole and backfilled with calcined petroleum coke breeze or metallurgical coke breeze. Backfill shall be compacted.

3.2.1.3 Horizontally Buried Canister-Contained Anodes

Horizontally buried canister-contained anodes shall be buried in a trench excavated for the purpose at depths, spacing, and locations shown.

3.2.1.4 Vertically Buried Canister-Contained Anodes

Vertically buried canister-contained anodes shall be installed in vertical holes in the ground having depth, spacing, and locations shown. The holes in the ground shall be sufficiently larger in diameter than the canisters to facilitate easy lowering into the hole and backfilling. The space between the canister and the wall of the hole shall be completely backfilled with a wet slurry of earth free of stones.

3.2.1.5 Cable Protection

Positive cable to the ground bed and negative cable to the [pipe] [tank] to be protected shall be buried a minimum depth of 30 inches except where above ground construction utilizing conduit is used.

3.2.1.6 Multiple Anode Systems

Multiple anode systems shall consist of groups of anodes connected in parallel to a header cable, buried in the ground at depths, spacing, and locations shown. The anodes shall be buried [horizontally] [vertically].

3.2.1.7 Distributed Anode Systems

Distributed anode systems shall consist of a line or row of anodes connected in parallel to a header cable and buried in the ground parallel to the pipeline. The anodes shall be at the pipeline at depths, spacing, and locations shown. The anodes shall be buried [horizontally] [vertically].

3.2.2 Deep Anode Ground Beds

Deep anode ground beds shall consist of an installation of anodes supported one above the other and supported in place by a method that does not suspend the anodes from the connecting cable. Deep anode ground beds shall be installed in accordance with NACE RP0572 and as specified in these specifications.

3.2.2.1 Anode Centering

Anodes shall be centered in the well by means of centering devices.

3.2.2.2 Casing

The casing shall be to a depth and elevation of not more than [_____] feet.

3.2.2.3 Casing Insulation

The portion of casing above the top anode shall be coated with an electrically insulating underground type coating.

3.2.2.4 Anode Requirements

Anode sizes, spacing, number of anodes, depth of well, and other details shall be as shown.

3.2.2.5 Anode Lead Wire

Each anode shall have a separate, continuous wire extending from the anode to the junction box at the well head.

3.2.2.6 Anode Cables

Anode cables shall terminate in a nearby junction box, equipped with individual anode current shunts. Where full length casing is used, two wire connections from casing shall terminate in the junction box.

3.2.2.7 Anode and Cable Installation

If the method of installation utilizes backfill support for anodes and cable, slack in the cable near each anode shall be provided and the cable insulation shall be increased in thickness from 7/64 to 5/32 inch utilizing an approved composite of plastic and elastomeric materials.

3.2.2.8 Backfill

The well shall be backfilled with calcined petroleum coke breeze or metallurgical coke breeze surrounding the anodes by a method that does not leave voids or bridging. The recommended method is to pump the backfill from the bottom upward. The well shall be over-filled with coke breeze allowing for settlement so that the settled level after a number of days is as high as the level shown. The number of days allowed for settling of the coke breeze will be determined by the Contracting Officer. If the top level of coke breeze is below the level shown after settlement, additional coke breeze shall be put in the well. The backfill used shall not require tamping. The top portion of the well shall be sealed for 25 feet to prevent surface water run-off. All vents shall be vented above the high water mark and at a safe height.

3.2.2.9 Cable Marker Tape

Traceable marker tape shall be located in the same trench above cathodic protection cables including structure leads, anode leads, anode header cables, test station leads, bonding cables, and rectifier electrical power cables.

3.2.2.10 Pavement Inserts

Pavement inserts shall be installed at a minimum of 100 foot intervals for pipelines. The pavement inserts shall be installed directly over the structure being protected and tested.

3.3 MAGNESIUM ANODE INSTALLATION

Installation shall not proceed without the presence of the Contracting Officer, unless otherwise authorized. Anode locations may be changed to clear obstructions when approved. Anodes shall be installed in sufficient number and of the required type, size, and spacing to obtain a uniform current distribution surface on the structure. Prepackaged anodes shall be installed as shown on the drawings.

3.3.1 Installation of Packaged Anodes

Packaged anodes shall be installed completely dry, and shall be lowered into holes by rope sling or by grasping the cloth gather. The anode lead wire shall not be used in lowering the anodes. The hole shall be backfilled with fine soil in 6 inch layers and each layer shall be hand-tamped around the anode. The tamper shall not strike the anode or lead wire. If immediate testing is to be performed, water shall be added only after backfilling and tamping has been completed to a point 6 inches above the anode. Approximately 2 gallons of water shall be poured into the hole; after the water is absorbed by the soil, backfilling and tamping shall be completed to the top of the hole. Anodes shall be installed as shown. When rock is found prior to achieving specified depth, anode may be installed horizontally to a depth at least as deep as the bottom of the pipe, with the approval of the Contracting Officer.

3.3.2 Underground Metal Pipe Line

Anodes shall be installed 2 feet below the line to be protected unless otherwise noted on the drawings. To facilitate periodic electrical measurements during the life of the sacrificial anode system and to reduce the output current of the anodes if required, anode lead wires in a single group of anodes shall be buried a minimum of 2 feet and each anode lead wire shall be connected to an individual terminal in a test station. The anode lead cable shall make contact with the structure only through a test station. Resistance wire shall be installed between the anode lead cable and the pipe cable in the test station to reduce the current output, if required.

3.3.3 Lead and Resistance Wire Splices

Lead wire splicing, when necessary, shall be made with copper split bolt connectors of proper size. The joint shall be carefully wrapped with at least 3 layers of electrical tape. Resistance wire connections shall be done with silver solder and the solder joints wrapped with a minimum of 3 layers of pressure-sensitive tape.

3.3.4 Magnesium Anodes for Metallic Components

As a minimum, each metallic component shall be protected with [2] [_____] [9] [17] [_____] lb magnesium anodes located on each side of the metallic component and routed through a test station. Fire hydrant pipe component shall have a minimum of [2] [3] [_____] [9] [17] [_____] lb magnesium anodes routed through a test station for each hydrant. Pipe under concrete slab shall have a minimum of [5] [_____] [17] [_____] lb anodes for each location where metal pipe enters the building under the slab. A permanent reference cell shall be provided adjacent to the pipe entrance to the slab. Conductors shall be routed to a test station. Each valve shall have a minimum of [2] [_____] [9] [_____] lb magnesium anodes routed through a test station. Sections of metallic pipe 20 foot long, when used where force mains are within 10 feet of the water pipe, shall have a minimum of [4] [_____] 17 lb anodes.

3.4 MISCELLANEOUS INSTALLATION

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NOTE: The cathodic protection system will fail unless full engineering considerations are applied to selection, location and installation of electrically conductive joints and electrically isolating joints including the use of underground type dielectric coatings (not paint).

Adequate electrical conductivity of a pipe joint made by means other than welding should be determined by the "corrosion expert." Allowable electrical resistance depends on the cross sectional area of the pipe metal, the resistivity of the pipe metal, and the effectiveness of the coating on the pipe. Effectively coated pipe underground requires only a fraction of the electrical conductivity at joints needed for bare pipe. Shop painted pipe is considered to be the same as bare pipe and is not to be confused with pipe coated with an underground type dielectric coating.

The type of electrical isolating pipe joint to be used requires engineering design consideration. In general, the dielectric parts of an isolating joint will not withstand structural or environmental stresses as well as an all-metal type of joint. If the pipe on the cathodic protected side of the underground electrically isolating pipe joint, including the joint, is not effectively coated, interference type corrosion may occur unless other measures are taken. Factors to be considered include:

a. Deflection stresses

b. Pull-out stresses

c. Expansion-contraction due to temperature changes

d. Is function as a union necessary?

e. Is field assembly of critical parts practical?

f. Hazardous locations to be avoided

g. Accessibility if above ground

h. Location of test box if below ground

i. Importance of coating the adjacent pipe if below ground

j. Vulnerability to short circuiting

Factor of safety on pull-out strength required has to be engineered for the specific conditions involved since no blanket provisions are fully applicable to all cases. The requirement for isolating flanges or couplings should be based on a study of the conditions. If the new piping is a short extension to an existing old piping system not under cathodic protection, an isolating fitting should be installed at the point of connection, since the new piping will be anodic to the older system. If the older system is under cathodic protection, no isolating fitting should be used.
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3.4.1 Rectifier Installation

Mounting shall be as shown. [Pole or wall mounting shall be equipped with a channel bracket, lifting eyes, and a keyhole at the top.] [Cross-arm brackets shall accommodate a 4 by 4 inch cross-arm.]

3.4.2 Wire Connections

3.4.2.1   Wire Splicing

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NOTE: In water tanks, split bolts are used (above the water line only) because working space is limited and the hydraulic or mechanical compression tools may be cumbersome and hazardous to use; since a single split-bolt will work loose when the wires it connects are moved, a minimum of two split bolts should be used. At ground level or in trenches, compression tools can be used conveniently, and the swaged sleeve connection produced by such tools is more reliable than split bolts..
****

Connecting wire splicing shall be made with copper compression connectors or exothermic welds, following instructions of the manufacturer. Split-bolt type connectors shall not be used.

3.4.2.2   Steel Surfaces

Connections to [ferrous pipe] [metal tanks] shall be made by exothermic weld methods as manufactured by an approved manufacturer for the type of [pipe] [tank]. Electric arc welded connections and other types of welded connections to ferrous pipe and structures shall be approved before use.

3.4.3   Pipe Joints

****
NOTE: This paragraph will be coordinated with and referenced in mechanical and electrical specifications.
****

3.4.3.1   Electrical Continuity

Underground pipe shall be electrically continuous except at places where electrically isolating joints are specified. Pipe joined by means other than welding shall meet the following electrical continuity requirements:

a. Mechanical joints that are not factory designed to provide electrical continuity shall be bonded by installing a metallic bond across the joint. The bonding connections shall be made by the exothermic welding process.

b. Mechanical joints designed to provide electrical continuity may be used.

3.4.3.2   Coating

Mechanical joints and fittings of either the electrically conductive or insulating type shall be coated with an underground type dielectric coating system. Where external electrical continuity bonds are installed across mechanical joints, bare or exposed metal, welds, bare wire and exposed coupling parts shall be coated with a coating system.

a. Couplings and fittings which have a low profile exterior designed to permit tape coating shall be primed and wrapped with an underground type pipe tape system or two-part epoxy system.

b. Couplings and fittings that cannot be properly taped shall be enclosed in a [spaced mold manufactured for the purpose] [shroud of reinforced kraft paper] and filled with [cold applied dielectric compound] [hot applied bituminous compound not exceeding 275 degrees F in application temperature].

3.4.3.3 Electrical Isolation of Structures

Electrical isolation of structures shall be as follows:

a. Isolating Fittings: Isolating flanges and couplings shall be installed aboveground, or within manholes, wherever possible, but an isolating device that electrically separates a pipeline shall not be installed in a confined area where a combustible atmosphere may collect unless precautions are taken to prevent arcing such as by means of externally located surge arresters, grounding cells, or other means. Isolating flanges and couplings in lines entering buildings shall be located at least 12 inches above grade or floor level. Pipelines entering buildings either below or above ground shall be electrically isolated from the structure wall with an electrically isolating [gas tight wall sleeve.] [wall sleeve.]

b. Gas Distribution Piping: Electrical isolation shall be provided at each building riser pipe to the pressure regulator, at all points where a short circuit to another structure or to a foreign structure may occur, and at other locations as indicated.

c. [Steam] [High Temperature] [Chilled] [Water] [Line Supply and Return Piping] [Line Conduit]: Electrical isolation shall be provided at each building entrance, and at other locations as indicated.

d. [Fuel] [Gasoline] [Storage Tanks] [Fire Suppression] [_____]: Electrical isolation shall be provided in each pipe [at the building] [at the tank] as shown.

e. Copper Piping: Copper piping shall be [electrically isolated at both ends of the pipe run] [wrapped with pipeline tape and electrically isolated at both ends].

f. Underground Storage Tanks (UST): Tanks shall be electrically isolated from other metallic structures. Components protected with the tank such as pipes, vents, anchors, and fill pipes shall be bonded to the tank.

3.4.4 Dissimilar Metals

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NOTE: This paragraph will be coordinated with and referenced in mechanical and electrical specifications.

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Buried piping of dissimilar metals including new and old steel piping, excepting valves, shall be electrically separated by means of electrically insulating joints at every place of connection. The insulating joint, including the pipes, shall be coated with an underground type dielectric coating for a minimum distance of 10 diameters on each side of the joint.

3.4.5 Ferrous Valves

Dissimilar ferrous valves in a buried ferrous pipeline, including the pipe, shall be coated with an underground type dielectric coating for a minimum distance of 10 diameters on each side of the valve.

3.4.6 Brass or Bronze Valves

Brass or bronze valves shall not be used in a buried ferrous pipeline.

3.4.7 Metal Pipe Junction

If the dissimilar metal pipe junction, including valves, is not buried and is exposed to atmosphere only, the connection or valve, including the pipe, shall be coated with an underground type dielectric coating for a minimum distance of 3 diameters on each side of the junction.

3.4.8 Casing

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NOTE: This paragraph will be deleted if mechanical and electrical specifications include these requirements.

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Where a pipeline is installed in a casing under a roadway or railway, the pipeline shall be electrically isolated from the casing, and the annular space sealed against incursion of water.

3.4.9 Test Stations

Test stations shall be of the type and location shown and shall be [curb box] [post] mounted. Buried electrically isolating joints shall be provided with test wire connections brought to a test station. Changes in designated location shall have prior approval. Unless otherwise shown, other test stations shall be located as follows:

a. At 1,000 foot intervals or less.

b. Where the pipe or conduit crosses any other metal pipe.

c. At both ends of casings under roadways and railways.

d. Where both ends of an insulating joint are not accessible above ground for testing purposes.

3.5 TESTS AND MEASUREMENTS

3.5.1 Baseline Potentials

Each test and measurement will be witnessed by the Contracting Officer. The Contractor shall notify the Contracting Officer a minimum of 5 working days prior to each test. After backfill of the [pipe] [tank] [_____] and anodes is completed, but before the anodes are connected to the [pipe] [tank] [_____], the static potential-to-soil of the [pipe] [tank] [_____] shall be measured. The locations of these measurements shall be identical to the locations specified for [pipe-] [tank-] [_____] to-reference electrode potential measurements.

3.5.2 Isolation Testing

Before the anode system is connected to the [pipe] [tank] [_____], an isolation test shall be made at each isolating joint or fitting. This test shall demonstrate that no metallic contact, or short circuit exists between the two isolated sections of the [pipe] [tank]. Any isolating fittings installed and found to be defective shall be reported to the Contracting Officer.

3.5.2.1 Insulation Checker

A Model 601 insulation checker, as manufactured by ["Gas Electronics"] [_____] [or] [an approved equal], shall be used for isolating joint (flange) electrical testing ing accordance with anufacturer's operating instructions. An isolating joint that is good will read full scale on the meter; if an isolating joint is shorted, the meter pointer will be deflected at near zero on the meter scale. Location of the fault shall be determined from the instructions and the joint shall be repaired. If an isolating joint is located inside a vault, the pipe shall be sleeved with insulator when entering and leaving the vault.

3.5.2.2 Cathodic Protection Meter

A Model B3A2 cathodic protection meter, as manufactured by ["M. C. Miller"] [_____] [or] [an approved equal] using the continuity check circuit shall be used for isolating joint (flange) electrical testing. This test shall be performed in addition to the Model 601 insulation checker. Continuity is checked across the isolated joint after the test lead wire is shorted together and the meter adjusted to scale. A full scale deflection indicates the system is shorted at some location. The Model 601 verifies that the particular insulation under test is good and the Model B3A2 verifies that the system is isolated. If the system is shorted, further testing shall be performed to isolate the location of the short.

3.5.3 Anode Output

After the rectifier is energized, the current output of the individual anode leads shall be measured by using an approved method. This may be done with a shunt and MV meter, a low-resistance ammeter, or a clamp-on milliammeter. The total current shall be measured and compared to the sum of all anode currents and to the rectifier output current. If an individual anode output current meets or exceeds the recommended output for that anode, the system shall be turned down or balancing resistors installed. Calculation of the wattage of the resistors shall be sufficient to handle the maximum load which will be encountered on the anode lead. All measurements obtained, the date, time, and locations of all measurements shall be recorded.

3.5.4 Electrode Potential Measurements

Upon completion of the installation and with the entire cathodic protection system in operation, electrode potential measurements shall be made using a copper-copper sulphate reference electrode and a potentiometer-voltmeter, or a direct current voltmeter having an internal resistance (sensitivity) of not less than 10 megohms per volt and a full scale of 10 volts. The locations of these measurements shall be identical to the locations used for baseline potentials. The values obtained and the date, time, and locations of measurements shall be recorded. No less than 8 measurements shall be made over any length of line or component. Additional measurements shall be made at each distribution service riser, with the reference electrode placed directly over the service line.

3.5.5   Location of Measurements

3.5.5.1   Coated Piping or Conduit

For coated piping or conduit, measurements shall be taken from the reference electrode located in contact with the earth, directly over the pipe. Connection to the pipe shall be made at service risers, valves, test leads, or by other means suitable for test purposes. Pipe to soil potential measurements shall be made at intervals not exceeding [2.5] [5] [400] [_____] feet. The Contractor may use a continuous pipe to soil potential profile in lieu of 2.5 ft interval pipe to soil potential measurements. Additional measurements shall be made at each distribution service riser, with the reference electrode placed directly over the service line adjacent to the riser. Potentials shall be plotted versus distance to an approved scale. Locations where potentials do not meet or exceed the criteria shall be identified and reported to the Contracting Officer.

3.5.5.2   Underground Tanks

For underground tanks, measurements shall be taken from the reference electrode located:

a. Directly over the center of the tank.

b. At a point directly over the tank and midway between each pair of anodes.

c. At each end of the tank.

A minimum of three measurements shall be made.

3.5.6   Casing Tests

Before final acceptance of the installation, the electrical separation of carrier pipe from casings shall be tested and any short circuits corrected.

3.5.7   Interference Testing

****
NOTE: Adverse effects may be caused by the foreign pipeline.
****

Before final acceptance of the installation, interference tests shall be made with respect to any foreign [pipes] [tanks] in cooperation with the owner of the foreign [pipes] [tanks]. A full report of the tests giving all details shall be made.

3.5.8   Holiday Test

Any damage to the protective covering during transit and handling shall be repaired before installation. After field coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current in accordance with NACE RP0188 using a full ring, spring type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Holidays in the protective covering shall be repaired upon detection. Occasional checks of holiday detector potential will be made by the Contracting Officer to determine suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection shall be furnished by the Contractor. The coating system shall be inspected for holes, voids, cracks, and other damage during installation.

3.5.9 Recording Measurements

All [pipe-] [tank-] to-soil potential measurements including initial potentials where required shall be recorded. The Contractor shall locate, correct and report to Contracting Officer any short circuits to foreign [pipes] [tanks] [_____] encountered during checkout of the installed cathodic protection system. [Pipe-] [Tank-] [_____] to-soil potential measurements are required on as many [pipes] [tanks] [_____] as necessary to determine the extent of protection or to locate short-circuits.

3.6 TRAINING COURSE

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of [16] [_____] hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations, including testing procedures included in the maintenance instructions. At least 14 days prior to date of proposed conduction of the training course, the training course curriculum shall be submitted for approval, along with the proposed training date. Training shall consist of demonstration of test equipment, providing forms for test data and the tolerances which indicate that the system works satisfactorily.

-- End of Section --

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U.S. ARMY CORPS OF ENGINEERS — **---------------------------**

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SECTION 13120

STANDARD METAL BUILDING SYSTEMS
09/98

****
NOTE: This guide specification covers the requirements for medium to large metal building systems designed in accordance with MBMA Low Rise Manual "1996 Low Rise Building Systems Manual" with loads and load combinations in accordance with ASCE 7. Section 13121 METAL BUILDING SYSTEMS (MINOR REQUIREMENTS) should be used for small, simple, utilitarian type buildings that do not require the higher level of performance and quality obtained by using this section. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: Metal building systems may be economical solutions for providing a usable structure if this type of system is acceptable to the user. Interior

finishing of metal buildings will be held to a minimum, and siting of metal buildings in areas inconsistent with their architectural appearance will be avoided.

In order to fully benefit from the inherent savings in utilizing acceptable components which are standard with the building manufacturers, items such as doors, windows, and ventilators will not be specified by reference to other sections based on the guide specifications for these items, unless the number of buildings required or the performance requirements are such as to make the references to other sections necessary.

Designs of acceptable metal building systems vary widely regarding such features as roof slopes, panel configurations, fastener types and spacings, covering lapping distances, and joint sealing methods, all of which have a direct bearing on the water tightness of the installation. Grounding for metal building systems is required, in accordance with Section 13100 LIGHTNING PROTECTION SYSTEM. In order to avoid placing undue restrictions on acceptable buildings, this guide specification includes only certain minimum requirements for these features and the requirement that the completed building be guaranteed.

This guide specification includes the requirements for the most commonly used materials and components; it is not possible to indicate all possible combinations and selections which may be utilized in adapting this guide specification to a particular project. Therefore, careful editing is necessary to assure that the project is properly and adequately specified.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA Standards & Data (1997) Aluminum Standards and Data

AA Design Manual	(1994) Aluminum Design Manual: Specification & Guidelines for Aluminum Structures

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 101	(1997) Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC FCD	(1995a) Quality Certification Program Description
AISC Pub No. S303	(1992) Code of Standard Practice for Steel Buildings and Bridges
AISC Pub No. S329	(1985; Appx A June 1994) Allowable Stress Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts
AISC Spec	(1989) Specification for Structural Steel Buildings - Allowable Stress Design, Plastic Design
AISC Pub No. S342 L	(1993) Load and Resistance Factor Design Specification for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI Cold-Formed Mnl	(1996) Cold-Formed Steel Design Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 252	(1998) Welded and Seamless Steel Pipe Piles
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 325M	(1997) High-Strength Bolts for Structural Steel Joints (Metric)
ASTM A 463/A 463M	(1997) Steel Sheet, Aluminum-Coated by the Hot-Dip Process
ASTM A 490	(1997) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
ASTM A 490M	(1993) High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel

	Joints (Metric)
ASTM A 500	(1998) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 501	(1998) Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 529/A 529M	(1996) High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A 570/A 570M	(1998) Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM A 572/A 572M	(1997c) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 588/A 588M	(1997) High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 in. (100 mm) Thick
ASTM A 606	(1998) Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A 607	(1998) Steel, Sheet and Strip, High-Strength, Low-Alloy, Columbium or Vanadium, or Both, Hot-Rolled and Cold-Rolled
ASTM A 618	(1997) Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
ASTM A 653/A 653M	(1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 792/A 792M	(1997) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	(1995) Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B 221M	(1996) Aluminum and Aluminum-Alloy Extruded Bars, rods, Wire, Profiles, and Tubes (Metric)
ASTM B 241/B 241M	(1996) Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

ASTM B 308/B 308M	(1996) Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B 429	(1995) Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM C 518	(1991) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 553	(1992) Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation
ASTM C 991	(1998) Flexible Glass Fiber Insulation for Pre-Engineered Metal Buildings
ASTM C 1289	(1998) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D 522	(1993a) Mandrel Bend Test of Attached Organic Coatings
ASTM D 523	(1989; R 1994) Specular Gloss
ASTM D 610	(1995) Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D 714	(1987; R 1994) Evaluating Degree of Blistering of Paints
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 1308	(1987; R 1998) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2244	(1993) Calculation of Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	(1997) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	(1993) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	(1997) Measuring Adhesion by Tape Test

ASTM D 3841	(1997) Glass-Fiber-Reinforced Polyester Plastic Panels
ASTM D 4214	(1998) Evaluating Degree of Chalking of Exterior Paint Films
ASTM D 4397	(1996) Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 4587	s(1991) Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light - and Water-Exposure Apparatus
ASTM D 5894	(1996) Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
ASTM E 84	(1998e1) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1995) Minimum Design Loads for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1998) Structural Welding Code - Steel

COE TECHNICAL INSTRUCTIONS (TI)

TI 809-04	(1998) Seismic Design for Buildings
TI 809-07	(1998) Design of Cold-Formed Load Bearing Steel Systems and Masonry Veneer/Steel Stud Walls

MATERIAL HANDLING INDUSTRY (MHI)

MHI CMAA 70	(1994) Electric Overhead Traveling Cranes

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA Low Rise Manual	(1996) Low Rise Building Systems Manual

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Arch. Manual	(1993; Errata; Addenda Oct 1997) Architectural Sheet Metal Manual

STEEL DOOR INSTITUTE (SDOI)

SDOI SDI-100	(1991) Standard Steel Doors and Frames

STEEL WINDOW INSTITUTE (SWI)

SWI Specifier's Guide	(1995) The Specifier's Guide to Steel Windows

UNDERWRITERS LABORATORIES (UL)

UL 580	(1994; Rev thru Sep 1997) Tests for Uplift Resistance of Roof Assemblies

1.2 GENERAL REQUIREMENTS

The metal building system covered under this specification shall be provided by a single manufacturer and shall include all components and assemblies that form a building. Structural Standing Seam Metal Roofing System, when specified, shall be furnished as part of a single manufacturer's system.

1.2.1 Building Configuration

****

NOTE: Gable roofs will be specified for all buildings, except where single-slope roofs are necessary for small buildings or for building extensions. Structures will be limited to single-span only when interior columns would adversely affect the use of the building.

Drawings will show roof slope in accordance with the guidance provided in TI 809-29 based on the type of roofing system specified. Drawings will show required width and length dimensions from inside face of wall covering; minimum inside clear dimensions; size, type, and number of windows, doors, louvers, ventilators, and skylight panels; hardware requirements, if not scheduled in the specifications, including requirements for door weather stripping and thresholds; and other information as required to supplement the specifications.

****

Buildings shall have structural steel main building frames, and secondary framing including purlins and girts, engineered and fabricated by the building systems supplier. Buildings shall have vertical steel walls and [gable] [single-slope] roof system including [soffits] [gutters and downspouts] [and] [______]. Roof slope shall be as shown on the drawings. Buildings shall be [single-span] [single-span or multiple-span] structures with one of the following framing systems: [self-framing] [column with single-span or continuous trusses] [continuous beam frames] [column with rigid frame] [rigid frame]. [Exterior doors] [windows] [overhead doors] [louvers] and [____] shall be included in the metal building system. Building dimensions shall be not less than those indicated. The minimum inside clear dimensions shall be as shown on the drawings.

1.2.2 Qualifications

1.2.2.1 Manufacturer

****

NOTE: The AISC Quality Certification Program can act as a pre-qualification system for structural steel fabricators. The purpose of the AISC Quality Certification Program is to confirm to the construction industry that a Certified structural steel fabricating plant has the personnel, organization, experience, procedures, knowledge, equipment, capability and commitment to produce fabricated steel of the required quality for a steel building.

****

Metal building shall be the product of a recognized steel building systems manufacturer who has been in the practice of manufacturing steel building systems for a period of not less than 5 years. The manufacturer shall be chiefly engaged in the practice of designing and fabricating steel building systems. The manufacturer shall be certified under the Metal Building Systems (MB) Certification Program, AISC FCD. Structural framing and covering shall be designed by a licensed Professional Engineer experienced in design of this work.

1.2.2.2 Installer

Erector shall have specialized experience in the erection of steel building systems for a period of at least 3 years. Framing shall be erected in accordance with MBMA Low Rise Manual, common industry practices and erection instructions describing the basic sequence of assembly, temporary bracing, shoring, and related information necessary for erection of the metal building including its structural framework and components. The erector shall furnish temporary guys and bracing where needed for squaring, plumbing, and securing the structural framing against loads acting on the exposed framing, such as wind loads and seismic forces, as well as loads due to erection equipment and erection operation. Bracing furnished by the manufacturer for the metal building system shall not be assumed to be adequate during erection. Structural members shall not be field cut or altered without approval of the metal building manufacturer. Welds, abrasions, and surfaces not [shop primed] [galvanized] shall be primed after erection.

1.2.2.3 Manufacturer's Representative

****

NOTE: Remove this paragraph when the manufacturer's representative is not required.

****

A representative designated by the building manufacturer, who is familiar with the design of the building supplied and experienced in the erection of metal buildings similar in size to the one required under this contract, shall be present at the job site during construction, from the start of the structural framing erection until completion of the installation of the exterior covering, to assure that the building is erected properly.

1.3 DESIGN REQUIREMENTS

****

NOTE: Metal buildings should be specified using MBMA criteria except that loads and load combinations will be in accordance with TI 809-01, which refers to ASCE 7 for wind, live and snow loads and TI 809-04 for earthquake loads.

****

Criteria and definitions shall be in accordance with MBMA Low Rise Manual, except criteria for seismic loads which shall be in accordance with TI 809-04 and all other loads and load combinations in accordance with ASCE 7.

1.3.1 Dead Loads

The dead load shall consist of the weight of all permanent construction such as roof, framing, covering members and all other materials of the building system.

1.3.2 Collateral Loads

Collateral load of [_____] pounds per square foot shall be applied to the entire structure to account for the weight of additional permanent materials other than the building system, such as sprinklers, mechanical systems, electrical systems, hung partitions, and ceilings. This allowance does not include the weight of hung equipment weighing 50 pounds or more. Equipment loads of 50 pounds or more shall be shown on the shop (detail) drawings and the structure (frame, purlins, girts) shall be strengthened as required. The Contractor is responsible for providing the building manufacturer the magnitude and approximate location of all concentrated loads greater than 50 pounds before design of the building commences.

1.3.3 Roof Live Loads

1.3.3.1 Uniform Loads

Uniform roof live loads, including maintenance traffic and construction loads, shall be determined and applied in accordance with ASCE 7.

1.3.3.2 Concentrated Loads

In addition to ASCE 7 roof live loads, a minimum design concentrated load of 300 pounds shall be used to simulate a construction load on roof panels. The concentrated load shall be applied at the panel midspan and shall be resisted by a single standing seam metal roof panel, or a 24 inches wide corrugated metal panel, assumed to be acting as a beam. The undeformed shape of the panel shall be used to determine the section properties.

1.3.4 Roof Snow Loads

The design roof snow loads, including effects of drifting, shall be determined and applied in accordance with ASCE 7.

1.3.5 Wind Loads

Wind pressures shall be computed and applied in accordance with ASCE 7.

1.3.6 Seismic Loads

Seismic loads shall be computed in accordance with TI 809-04.

1.3.7 Impact Loads

Impact loads due to [monorails] [cranes] [and] [_____] of [_____] magnitude shall be applied as indicated in [MBMA Low Rise Manual] [AISC Spec].

1.3.8 Foundations

****

NOTE: The following paragraph is intended to be a synopsis of the foundation report, and will be supplemented with additional data as required. Coordinate with paragraph DESIGN ANALYSIS.

When dealing with soil, a larger factor of safety is used. Unlike steel and concrete, which are manufactured, controlled, and tested to meet prescribed standards, soils are natural materials. Therefore it is common practice to apply a factor of safety of at least 3.0 in soil engineering work.

****

Foundations shall be designed for an allowable soil bearing pressure of [_____] psf, a minimum bottom of footing depth of [_____] feet below finish floor elevation, a factor of safety of 1.5 for overturning, sliding and uplift, and a concrete compressive strength as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

1.3.9 Framing and Structural Members

****

NOTE: Designer will edit this paragraph to reflect the project requirements. The structural system of a metal building system is the frame that supports the roof, walls, and all externally applied loads. The selection of the framing type is determined by a combination of economics, function, and usage. These are the most common types of framing systems in use today: 1) Single span rigid frame, usually tapered. 2) Continuous beam frame, post-and-beam. 3) Tapered beam with type II connections at the columns. 4) Single span and continuous trusses and 5) Lean-to. Wall systems usually consist of wall panels and girts. The girts consist of cold formed "C" or "Z" sections, are attached to the columns of the primary frame, and support the wall panel against lateral loads. Roof systems usually consist of purlins and roof panels. The purlins support the weight of the roof and any applied loads, and transfer these loads to the primary structural system. Two types of purlins in common use are cold formed steel "Z" or "C" sections and open web

joists. Delete the last sentence (on purlin and sub-purlin spacing) unless a Structural Standing Seam Metal Roof System is to be installed.
****

Structural steel members and their connections shall be designed in accordance with AISC Spec or AISC Pub No. S342 L. Structural cold-formed steel framing members and their connections shall be designed in accordance with TI 809-07. Aluminum structural members and their connections shall be designed in accordance with AA Design Manual. Maximum deflection under applied live load, snow, or wind load shall not exceed 1/180th of the span length. Members with openings in their webs shall be designed with consideration of the additional stresses which will result due to the openings. Deflections of the steel framing above and along the side of commercially framed door openings shall be limited to a maximum allowable deflection of 1/360 of the opening width to ensure proper operation of the doors. The contractor shall include the loads that the door transfers to the building frame in the design. Framed openings shall be designed to structurally replace the covering and framing displaced. The subpurlin and/or purlin spacing shall not exceed 30 inches on centers at the corner, edge and ridge zones, and 5 foot maximum on centers for the remainder of the roof. The maximum deflection of steel framing that provides lateral support for masonry veneer panels shall be 1/600 of the height of framing span.

1.3.10   Roofing and Siding

Except as otherwise specified, steel roofing and siding shall be designed in accordance with AISI Cold-Formed Mnl. Aluminum roofing and siding shall be designed in accordance with AA Standards & Data. Section modulus and moment of inertia of aluminum sheet shall be determined for actual cross section dimensions by the conventional methods for actual design stresses and by effective width concept for deflection in accordance with AA Design Manual. Maximum deflection for wall and roof panels under applied live load, snow or wind loads shall not exceed 1/180th of the span length. The design analysis shall establish that the roof, when deflected under loading combinations, shall not result in ponding. Maximum deflections shall be based on sheets continuous across two or more supports with sheets unfastened and fully free to deflect. The calculated deflection from the concentrated load shall not exceed 1/180 of the span length. The methods for resisting lateral loads shall be cross-bracing, rigid frames, or wind columns.

1.3.11   Provisions for Gutters And Downspouts

Gutters and downspouts shall be designed according to the requirements of SMACNA Arch. Manual for storms which should be exceeded only once in 5 years and with adequate provisions for thermal expansion and contraction. Supports for gutters and downspouts shall be designed for the anticipated loads. Roof drainage system to withstand rainfall intensity of [_____] inches per hour, with 5 minute duration.

1.3.12   Provisions for Louvers

Louvers shall be [fixed-blade] [adjustable] type designed for a minimum net open area of [_____] square feet, to be rainproof, and to resist vibration when air is passed at the rate of [_____] cubic feet per minute.

1.3.13   Ventilators

1.3.13.1.1 Circular Ventilators

Circular roof ventilators shall be gravity [directional] [stationary] [revolving] type, [with] [without] dampers, designed for a minimum capacity of [_____] cubic feet of air per minute for each ventilator, based on a wind velocity of 5 miles per hour and an exterior-interior temperature differential of 10 degrees F and without screens in place.

1.4 Continuous Ventilators

Continuous roof ventilators shall be ridge mounted gravity type, [with] [without] dampers, designed for a minimum capacity of [_____] cubic feet of air per minute for each 10 foot section based on a wind velocity of 5 miles per hour and an exterior-interior temperature differential of 10 degrees F and without screens in place.

1.5 Drift Provisions

****

NOTE: When masonry walls are anchored to the steel framing, the maximum allowable deflection of the wall will be used as a limiting value for the structure drift. Complete masonry design and details must be shown on the drawings. Sections A6 and A15 of MBMA Low Rise Manual should be reviewed when determining drift limitations.

****

Lateral deflections, or drift, at the roof level of a structure in relation to the floor or slab on grade, caused by deflection of horizontal force resisting elements, shall [conform to MBMA Low Rise Manual] [be less than [_____] inches].

1.6 Cranes

****

NOTE: Delete this paragraph when cranes are not required. To properly specify a crane, the designer must provide complete crane data to the Builder. Crane data sheets commonly supplied by a crane manufacturer do not provide the complete specifications necessary for the design of a crane for a building.

In specifying crane data, it is important that consideration be given to future operations which could increase crane loadings and fatigue. Special drift requirements must be specified on the Contract Documents.

****

The crane loads shall be obtained from the crane manufacturer and shall be applied per MBMA Low Rise Manual for the design of the crane runways and supports. The cranes, girders, rails, end trucks, stops, and bumpers shall be provided by the crane manufacturer as specified in Section 14630 OVERHEAD ELECTRIC CRANES. Cranes with a capacity greater than 10 tons shall [be supported by a structural system which is separate from the building frames except for lateral support. Flexible connections to the building columns, if used, shall allow the separate crane support system to resist longitudinal crane loads by other means without over stressing the building frame. Likewise, the building frame shall be free to deflect without over stress caused by connections to the more rigid crane support system] [_____].

1.7 Grounding and Lightning Protection

Grounding and lightning protection shall be provided as specified in Section 13100 LIGHTNING PROTECTION SYSTEM.

1.8 DESIGN ANALYSIS

****

NOTE: Metal Building System manufacturers do not design foundations; foundation investigation and design may be performed by the Contractor. The project design structural engineer must design and detail the foundations based on loads obtained for similar building types with the specified loading. The drawings should contain notes indicating that the foundations are provided for bid purposes only and that actual foundations, using similar details, will be provided by the Contractor.

****

The design analysis shall be the design of a licensed Professional Engineer experienced in design of this work and shall include complete calculations for the building, its components, and the foundations. Foundations shown on the drawings are based on loads derived from a representative set of similar building types. The Contractor shall obtain the services of a licensed Professional Engineer to verify that the foundations shown are adequate for the building supplied using the criteria in paragraph Foundations. Formulas and references shall be identified. Assumptions and conclusions shall be explained, and cross-referencing shall be clear. Wind forces on various parts of the structure, both positive and negative pressure, shall be calculated with the controlling pressure summarized. Lateral forces due to seismic loading shall be calculated and tabulated for the various parts and portions of the building. Computer programmed designs shall be accompanied by stress values and a letter of certification, signed by a licensed Professional Engineer, stating the design criteria and procedures used and attesting to the adequacy and accuracy of the design. A narrative of the computer program delineating the basic methodology shall be included. Computer program output shall be annotated and supplemented with sketches to verify the input and output. Critical load conditions used in the final sizing of the members shall be emphasized. The design analysis shall include the name and office phone number of the designer, who shall function as a point of contact to answer questions during the detail drawing review.

1.9 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary

factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" where the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Design Analysis; [_____].

Design analysis (building and foundations including anchor bolt plans) as one package with the drawings.

Instruction Manuals; [_____].

Manufacturer's literature for individual building component systems.

Erection Procedures; [_____].

Manufacturer's erection instruction and erection drawings describing the preparation requirements, assembly sequence, temporary bracing, shoring, and related information necessary for erection of the metal building including its structural framework and components.

SD-04 Drawings

Metal Building Systems; [_____].

Detail drawings consisting of catalog cuts, design and erection drawings, and an isometric view of the roof showing the design wind uplift pressure and dimensions of edge and corner zones. Shop painting and finishing specifications. Anchor bolt placement plan and column reactions.

SD-08 Statements

Qualifications; [_____].

Qualifications of the manufacturer, the manufacturer's Representative when one is used, and qualifications and experience of the building erector. A brief list of locations where buildings of similar design have been used shall be included with the detail drawings and shall also include information regarding date of completion, name and address of owner, and how the structure is used.

SD-13 Certificates

Metal Building Systems; [_____].

a. A Certificate from the metal building manufacturer stating that the metal building was designed from a complete set of the contract drawings and specifications and that the building furnished complies with the specified requirements.

b. Mill certification for structural bolts, framing steel, roofing and siding, and steel wall liner panels.

c. Warranty certificate. At the completion of the project the Contractor shall furnish signed copies of the 5-year Warranty for Metal Building System, a sample copy of which is attached to this section, the 20-year Manufacturer's Material Warranties, and the Manufacturer's 20-year System Weathertightness Warranty when one is required.

Insulation; [_____].

Certificate attesting that the polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

SD-14 Samples

Accessories; [_____].

One sample of each type of flashing, trim, closure, cap and similar items. Size shall be sufficient to show construction and configuration.

Roofing and Siding; [_____].

One piece of each type and finish (exterior and interior) to be used, 9 inches long, full width. The sample for factory color finished covering shall be accompanied by certified laboratory test reports showing that the sheets to be furnished are produced under a continuing quality control program and that a representative sample consisting of not less than 5 pieces has been tested and has met the quality standards specified for factory color finish.

Fasteners; [_____].

Two samples of each type to be used, with statement regarding intended use. If so requested, random samples of bolts, nuts, and washers as delivered to the job site shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

Insulation; [_____].

One piece of each type to be used, and descriptive data covering installation.

Gaskets and Insulating Compounds; [_____].

Two samples of each type to be used and descriptive data.

Sealant; [_____].

One sample, approximately 1 pound, and descriptive data.

Skylights; [_____].

One piece, 9 inches long, full width.

Wall Liners; [_____].

One piece, 9 inches long, full width.

1.10 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials other than framing and structural members shall be covered with weathertight coverings and kept dry. Storage accommodations for roofing and siding shall provide good air circulation and protection from surface staining.

1.11 WARRANTIES

The Metal Building System, composed of framing and structural members, roofing and siding, gutters and downspouts, accessories, fasteners, trim, and miscellaneous building closure items such as doors and windows (when furnished by the manufacturer) shall be warranted as described below against material and workmanship deficiencies, system deterioration caused by exposure to the elements and service design loads, leaks and wind uplift damage. Any emergency temporary repairs conducted by the owner shall not negate the warranties.

1.11.1 Prime Contractor's Weathertightness Warranty

The Metal Building System shall be warranted by the Contractor on a no penal sum basis for a period of five years against materials and workmanship deficiencies; system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks, and wind uplift damage. The Metal Building System covered under this warranty shall include but is not limited to the following: framing and structural members, roofing and siding panels and seams, interior or exterior gutters and downspouts, accessories, fasteners, trim, flashings and miscellaneous building closure items such as doors and windows (when furnished by the manufacturer), connectors, components, and fasteners, and other system components and assemblies installed to provide a weathertight system; and items specified in other sections of these specifications that become part of the metal building system. All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks and wind uplift damage shall be repaired as approved by the Contracting Officer. See the attached Contractor's written warranty for issue resolution of warrantable defects. This warranty shall warrant and cover the entire cost of repair or replacement, including all material, labor, and related markups. The Contractor shall supplement this warranty with written warranties from the installer and/or system manufacturer, which shall be submitted along with Contractor's warranty. However, the Contractor is ultimately responsible for this warranty. The Contractor's written warranty shall be as outlined in attached **WARRANTY FOR METAL BUILDING SYSTEMS,** and start upon final acceptance of the facility. The Contractor shall provide a separate bond in an amount equal to the installed total metal building system cost in favor of the owner (Government) covering the Contractor's warranty responsibilities effective throughout the five year Contractor's warranty period for the entire metal building system as outlined above.

1.11.2 Manufacturer's Material and/or System Weathertightness Warranties

The Contractor shall furnish, in writing, the following manufacturer's material warranties to the Contracting Officer which cover all Metal Building System components:

a. A manufacturer's 20 year material warranty warranting that the specified aluminum, zinc-coated steel, aluminum-zinc alloy coated steel or aluminum-coated steel will not rupture, structurally fail, fracture, deteriorate, or become perforated under normal design atmospheric conditions and service design loads. Liability under this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated, or structurally failed securement system including fasteners and coil material.

b. A manufacturer's 20 year exterior material finish warranty on the factory colored finish warranting that the finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of eight, as determined by ASTM D 4214test procedures; or change colors in excess of five CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. Liability under this warranty is exclusively limited to replacing the defective coated material.

1.12 COORDINATION MEETING

A coordination meeting shall be held within 45 days after contract award for mutual understanding of the metal building system contract requirements. This meeting shall take place at the building site and shall include representatives from the Contractor, the roofing/metal building system manufacturer, the roofing/metal building supplier, the erector, the designer, and the Contracting Officer. All items required by paragraph SUBMITTALS shall be discussed, including applicable standard manufacturer shop drawings, and the approval process. The Contractor shall coordinate time and arrangements for the meeting

PART 2 PRODUCTS

2.1 BUILDING COMPONENTS

Each piece or part of the assembly shall be clearly and legibly marked to correspond with the drawings.

2.2 FRAMING AND STRUCTURAL MEMBERS

Steel 1/8 inch or more in thickness shall conform to ASTM A 36/A 36M, ASTM A 529/A 529M, ASTM A 572/A 572M, or ASTM A 588/A 588M. Uncoated steel less than 1/8 inch in thickness shall conform to ASTM A 570/A 570M, ASTM A 606, or ASTM A 607. Galvanized steel shall conform to ASTM A 653/A 653M, G 90 coating designation, 0.045 inch minimum thickness. Aluminum-zinc coated steel shall conform to ASTM A 792/A 792M, [AZ 55] [AZ50] coating designation,) 0.045 inch minimum thickness. Aluminum sheet shall conform to ASTM B 209, 0.032 inch minimum thickness. Aluminum structural shapes and tubes shall conform to ASTM B 221, or ASTM B 308/B 308M. Structural pipe shall conform to ASTM A 53, ASTM A 252, ASTM A 500, ASTM A 501, ASTM A 618, ASTM B 221, ASTM B 241/B 241M or ASTM B 429. Holes for structural connections shall be made in the shop.

2.3 ROOFING AND SIDING

****

NOTE: Designer will edit this paragraph to reflect

the project requirements. Aluminum and steel are indicated as optional covering materials. Because of its superior corrosion resistance, aluminum can be used where steel is inappropriate. Because of the high cost of aluminum, its relative weakness and high thermal movement, steel is generally the appropriate choice for most projects. These materials should not be specified as optional materials, but should be specifically selected based on the requirements of the project.

For most conditions the designer will leave the overlapping or interlocking configurations and the exposed penetrating fasteners or the nonpenetrating fastener system as alternative choices for wall panels. Height of corrugations should be determined with relation to roof slope and the guidance provided in TI 809-29. Length of roofing panels may be controlled by shipping limitations (approximately 13 m (42 feet)).

When standing seam metal roofs are desired use Section 07416 STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM.

****

Roofing and siding shall be either steel or aluminum and shall have a [factory color] [mill] finish.

2.3.1 Roofing

[Roofing is specified in Section 07416 STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM.] [Length of sheets shall be sufficient to cover the entire length of any unbroken roof slope unless otherwise approved. Width of sheets with [overlapping configurations shall provide not less than 24 inches of coverage in place] [interlocking ribs shall provide not less than 12 inches of coverage in place]. Provisions shall be made for thermal expansion and contraction consistent with the type of system to be used. Panel shall have configurations for overlapping sheets. Roof deck assemblies shall be Class 90 as defined in UL 580. Exposed, penetrating fastener may be used. Height of corrugation at overlap of adjacent roof sheets shall be [the building manufacturer's standard for the indicated roof slope] [_____].]

2.3.2 Siding

Length of sheet shall be sufficient to cover the entire height of any unbroken height of wall surface unless otherwise approved. Width of sheets with [overlapping configurations shall provide not less than 24 inches of coverage in place] [interlocking ribs shall provide not less than 12 inches of coverage in place]. Provisions shall be made for thermal expansion and contraction consistent with the type of system to be used. Siding shall have [configurations for overlapping adjacent sheets] [or] [interlocking ribs for securing adjacent sheets]. Siding shall be fastened to framework using [exposed] [or] [concealed] fasteners.

2.3.3 Steel Panels

****

NOTE: When a factory color finish is specified remove last two sentences from this paragraph. AZ 50 coating is allowed for factory color-finished and not for mill finish.

****

[Steel roofing panels are specified in Section 07416 STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM.] [Roofing and Siding] [Siding] shall be zinc-coated steel conforming to ASTM A 653/A 653M, G 90 coating designation; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M, AZ [55] [50] coating; or aluminum-coated steel conforming to ASTM A 463/A 463M, Type 2, coating designation T2 E5. Panels shall be 0.024 inch thick minimum, except that when the mid field of the roof is subject to design wind uplift pressures of 60 psf or greater or the steel covering is used as a diaphragm, the entire roof system shall have a minimum thickness of 0.030 inch. Prior to shipment, mill finish panels shall be treated to inhibit the formation of oxide corrosion. Panels that have become wet during shipment but have not started to oxidize shall be dried, and retreated in accordance with manufacturer's standard practice.

2.3.4 Aluminum Panels

[Aluminum roofing panels are specified in Section 07416 STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM.] [Roofing and Siding] [Siding] shall be aluminum alloy conforming to ASTM B 209, temper as required for the forming operation, minimum 0.032 inch thick.

2.3.5 Factory Insulated Panels

****

NOTE: Factory insulated panels shall only be used to meet portability requirements or other operational requirements. This paragraph will be used in conjunction with the previous paragraphs properly edited as required for the design.

Select flame spread rating of 25 and smoke developed rating of 450 for Class A interior finish as defined in NFPA 101, and select 75/450 for Class B interior finish.

The designer will determine the required R-value of the assembled panel at 24 degrees C (75 degrees F) in accordance with ASTM C 236, and will show the R-value at the appropriate detail on the drawing.

****

Insulated [wall] [wall and roof] panels shall be factory-fabricated units with insulating core between metal face sheets, securely fastened together and uniformly separated with rigid spacers, facing of steel or aluminum of composition and gauge specified for covering, constructed in a manner that will eliminate condensation on interior of panel. Panels shall have a [factory color] [mill] finish. Insulation shall be compatible with adjoining materials; nonrunning and nonsettling; capable of retaining its R-value for the life of the metal facing sheets; and unaffected by extremes of temperature and humidity. The assembly shall have a flame spread rating not higher than [25] [75], and smoke developed rating not higher than 450 when tested in accordance with ASTM E 84. The insulation shall remain odorless, free from mold, and shall not become a source of food and shelter for insects. Panels shall be not less than 8 inches wide and shall be in one piece for unbroken wall heights.

2.3.6 Factory Color Finish

****

NOTE: Factory color finish will be specified except when the buildings are to be used for temporary purposes or where mill finish aluminum panels provide an acceptable appearance. If factory color finish is not required, document the rationale for the decision in the design analysis and remove this paragraph.

The US Metal Building Industry offers a variety of color finishes to protect the metal panels against chemical corrosion and ultraviolet radiation; to provide long life with minimum maintenance plus acceptable weathering and color retention; and to assure chalk, fade, and mar resistance. Some of the most widely used coatings include, but are not limited to, the following:

a. Polyvinylidene fluoride (PVF2); a nominal 0.025 mm (1 mil) thick coating modified with a proprietary resin for toughness; it may be used in most environments.

b. Silicone-modified polyester (SMP); a thermoset coating system composed of polyester resin modified by copolymerization with a functional silicone resin intermediate designed for added protection against chemical corrosion and ultraviolet radiation.

c. Plastisol (PVC); a two-coat system consisting of a polyvinyl-chloride resin dispersed in a plasticizer top-coat over a corrosion-resistant primer; it is a high-performance, thick coating designed for highly aggressive and corrosive environments with excellent resistance to common acids, alkalis, and inorganic compounds.

Most coatings may be ordered extra-thick for buildings in direct contact with salt or chemical laden air or where a premium finish would be justified. The thicker coating provides additional primer and increases the coating's corrosion and abrasion resistance but it requires a special run by the coil coater, at least a 22 degrees C (70 degrees F) environment, and additional delivery time. Appropriate specification requirements must be added

if the thick film coatings are to be used.

The high cost of preventing corrosion of galvanized steel panels, together with the fact that cut edges, scratches and penetrations of the panels expose the steel substrate, warrants consideration for the use of solid aluminum which is inherently less susceptible to damaging corrosion.

Exterior wall and roof panels are available in several standard colors. Standard trim colors are usually more limited. Except where interior surfaces receive a factory color coat, the exposed reverse side of the panels normally are provided with an off-white backer coating. Color other than manufacturer's standard colors will be used only when the extra cost is justified.

The choice of coating for the interior face of panels depends on environmental and aesthetic considerations. Where a corrosive atmosphere is anticipated within the structure, the finish should be PVF2 in a thickness appropriate to the environment. For utilitarian facilities with little likelihood of a detrimental atmosphere, a standard backer coat is appropriate. Backer coat is the manufacturer's standard coating (usually polyester based) applied to the back side of the metal panel. This coating is normally a wash coating and is not controlled for consistent color or gloss. Where interior surfaces are concealed behind insulation, liner panels, etc.; provide only a primer coat. These finishes should not be confused with a wash coat which is used primarily to facilitate the coil forming process and which is not closely controlled for color, gloss or film thickness. The designer's rationale for using any special interior finish should be reflected in the design analysis.

Energy considerations must be included in the choice of standard colors for the roof panels. White or light-colored roofing surfaces are much better at reflecting sunlight than darker surfaces. This keeps roofs 20 to 35 degrees C (35 to 60 degrees F) cooler, which means less heat will be transferred to internal building spaces. Demonstration projects have shown that cooling energy use can be cut by as much as 40 percent when light-colored surfaces are used. Coordinate the use of light-colored roofing material with the user.

****

Panels shall have a factory applied [polyvinylidene fluoride] [_____] finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. Color shall match the color indicated [on the drawings] [in Section 09915 COLOR SCHEDULE]. The exterior coating shall be a nominal [1] [2] mil thickness consisting of a topcoat of not less than 0.7 mil dry film thickness and the paint manufacturer's recommended primer of not less than [0.2] [1.0] mil thickness. The interior color finish shall consist of [the same coating and dry film thickness as the exterior] [a nominal 1 mil thick [PVF2] [_____] finish otherwise the same as the exterior] [a backer coat with a dry film thickness of 0.5 mil] [a 0.2 mil thick prime coat]. The exterior color finish shall meet the test requirements specified below.

2.3.6.1 Salt Spray Test

****

NOTE: The results of the salt spray test will vary depending on the thickness of the coating.

****

A sample of the sheets shall withstand a cyclic corrosion test for a minimum of 2016 hours in accordance with ASTM D 5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 10, no blistering, as determined by ASTM D 714; 10, no rusting, as determined by ASTM D 610 and a rating of 6, over 1/16 to 1/8 inch failure at scribe, as determined by ASTM D 1654.

2.3.6.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 1/8 inch diameter mandrel, the coating film shall show no evidence of cracking to the naked eye.

2.3.6.3 Accelerated Weathering, Chalking Resistance and Color Change

****

NOTE: The ASTM G 23 test is considered "outdated and unreliable" by MBMA; it is extremely expensive and labor intensive to run. The ASTM D 4587 test is currently the most reliable accelerated test method for predicting durability. Also worth considering is the ASTM D 4141 test.

Low gloss finishes have relatively poor weathering qualities. Delete the last sentence if a low gross finish is not required by Paragraph Specular Gloss.

****

A sample of the sheets shall be tested in accordance with ASTM D 4587, test condition [B] [D] for [_____] total hours. The coating shall withstand the weathering test without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with tape in accordance with ASTM D 3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. For sheets required to have a low gloss finish, the chalk rating shall be not less than No. 6 and the color difference shall be not greater than 7 units.

2.3.6.4   Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

2.3.6.5   Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 0.500 inch diameter hemispherical head indenter, equal to 1.5 times the metal thickness in mils, expressed in inch-pounds, with no loss of adhesion.

2.3.6.6   Abrasion Resistance Test

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of [50] [80] liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

2.3.6.7   Specular Gloss

****

NOTE: Few manufacturers regularly produce prefinished panels meeting these low gloss requirements and such sheets are available only in limited colors. Standard 70 percent PVF2 finish, for example, has a medium gloss. Low gloss paint formulations result in reduced weathering properties. Identify individual facilities requiring low gloss finish.

For roof of structures at airfields where glare would be objectionable and may be an operational hazard, the specular gloss value should be limited to 10 or less at an angle of 85 degrees.

****

Finished roof surfaces for [_____] shall have a specular gloss value of [10 or less at an angle of 85 degrees] [30 plus or minus [_____] at 60 degrees] when measured in accordance with ASTM D 523.

2.3.6.8   Pollution Resistance

Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

2.3.7   Accessories

Flashing, trim, metal closure strips and curbs, fascia, caps, diverters, and similar metal accessories shall be the manufacturer's standard products. Exposed metal accessories shall be finished to match the building finish. Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chloride premolded to match configuration of the roofing or siding and shall not absorb or retain water.

2.4 WALL LINERS

****

NOTE: Wall liners will be specified when necessary to provide protection to the insulation and will be the minimum height consistent with the use of the building. When full-height liners are required, they should be specified under this paragraph in lieu of using factory insulated panels. Wall liners of plywood, hardboard or other suitable materials may be used when considered to be more appropriate than sheet metal liners and when these materials will meet the fire hazard classifications required for the installation. If alternative liners are used, omit the following paragraph and show the supplementary supports for the liner on the drawings.

****

Wall liners shall be 0.024 inch thick minimum for aluminum or 0.018 inch thick minimum for steel with the same composition specified for siding, and formed or patterned to prevent waviness and distortion, and shall extend from floor to [a height of not less than [_____] feet above the floor.] [the ceiling.] Matching metal trim shall be provided [at base of wall liner,] [at top of wall liner,] [around openings in walls] [and over interior and exterior corners]. Wall liners shall have [the same factory color finish as specified for the exterior face of the wall panels.] [manufacturer's standard finishes.] Colors shall be [selected from manufacturer's standard finishes] [as indicated].

2.5 FASTENERS

****

NOTE: Fasteners that are not color coated may be limited to 400-series corrosion resisting steel when warranted by atmospheric exposure conditions.

****

Fasteners for [standing seam metal roofs shall be in accordance with Section 07416 STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM.] [steel wall [and roof] panels shall be zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for aluminum wall panels shall be aluminum or corrosion resisting steel. Fasteners for attaching wall panels to supports shall provide both tensile and shear strength of not less than 750 lbs per fastener. Fasteners for accessories shall be the manufacturer's standard. Exposed wall fasteners shall be color finished or provided with plastic color caps to match the covering. Nonpenetrating fastener system for wall panels using concealed clips shall be manufacturer's standard for the system provided.]

2.5.1 Screws

Screws shall be as recommended by the manufacturer to meet the design strength requirements.

2.5.2 End-Welded Studs

Automatic end-welded studs shall be shouldered type with a shank diameter of not less than 3/16 inch and cap or nut for holding covering against the shoulder.

2.5.3 Explosive Actuated Fasteners

Fasteners for use with explosive actuated tools shall have a shank of not less than 0.145 inch with a shank length of not less than 1/2 inch for fastening panels to steel and not less than 1 inch for fastening panels to concrete.

2.5.4 Blind Rivets

Blind rivets shall be aluminum with 3/16 inch nominal diameter shank or stainless steel with 1/8 inch nominal diameter shank. Rivets shall be threaded stem type if used for other than the fastening of trim. Rivets with hollow stems shall have closed ends.

2.5.5 Bolts

Bolts shall be not less than 1/4 inch diameter, shouldered or plain shank as required, with proper nuts.

2.6 GUTTERS AND DOWNSPOUTS

Gutters and downspouts shall be fabricated of aluminum, zinc-coated steel or aluminum-zinc alloy coated steel and shall have manufacturer's [standard] [factory color] [mill] finish. Minimum uncoated thickness of materials shall be 0.018 inch for steel and 0.032 inch for aluminum. All accessories necessary for the complete installation of the gutters and downspouts shall be furnished. Accessories shall include gutter straps, downspout elbows, downspout straps and fasteners fabricated from metal compatible with the gutters and downspouts.

2.7 LOUVERS

Louvers shall be fabricated of aluminum, zinc-coated steel, or aluminum-zinc alloy coated steel; shall have manufacturer's [standard] [factory color] [mill] finish; and shall be furnished with [bird] [insect] screens. Minimum uncoated thickness of materials shall be 0.048 inch for steel and 0.064 inch for aluminum. Manually operated louvers shall be designed to be opened and closed from the operating floor.

2.8 CIRCULAR ROOF VENTILATORS

Circular roof ventilators shall be fabricated of aluminum or zinc-coated steel; shall have manufacturer's [standard] [factory color] [mill] finish, and shall be furnished with [[bird] [insect] screens] [and] [chain or cable operated dampers]. Minimum uncoated thickness of materials shall be 0.018 inch for steel and 0.032 inch for aluminum. Ventilators shall be designed to provide weathertight construction.

2.9 CONTINUOUS ROOF VENTILATORS

Continuous roof ventilators shall be fabricated of aluminum, zinc-coated steel, or aluminum-zinc alloy coated steel, shall have manufacturer's [standard] [factory color] [mill] finish, and shall be furnished with [[bird] [insect] screens] [and] [chain or cable operated dampers]. Minimum uncoated thickness of materials shall be 0.018 inch for steel and 0.032 inch for aluminum. Ventilators shall be furnished in 8 to 10 feet long sections braced at midlength.

2.10 SKYLIGHTS

****

NOTE: A polyvinyl fluoride film coating may be specified for the exterior surface of skylight panels when longer wearability is considered necessary. For fire rated construction, panels with fire ratings consistent with the overall construction of the building should be specified.

****

Skylight panels shall be fabricated of [glass-fiber reinforced polyester] [or] [extruded cellular thermoplastic polycarbonate] panels conforming to ASTM D 3841, Class [_____], and other appropriate lab test criteria required, weighing not less than 8 ounces per square foot. Size and color of skylight panels shall be as indicated.

2.11 TRANSLUCENT PANELS

****

NOTE: A polyvinyl fluoride film coating may be specified for the exterior surface of translucent panels when longer wearability is considered necessary. For fire rated construction, panels with fire ratings consistent with the overall construction of the building should be specified.

****

Translucent panels shall be manufacturer's standard conforming to ASTM D 3841, Class [_____], weighing not less than 8 ounces per square foot. Size and color of translucent panels shall be as indicated.

2.12 DOORS

****

NOTE: Select door types for commercially framed openings. Delete unused door types, and renumber paragraphs as appropriate. Referenced door specification sections will be made a part of the project specifications and coordinated.

****

2.12.1 Hinged Doors

Hinged doors and frames shall receive a galvanic coating and factory primer and shall conform to [SDOI SDI-100, Type, Grade and size as indicated] [the requirements of Section 08110 STEEL DOORS AND FRAMES]. Exterior doors shall have top edges closed flush and sealed against water penetration. Hardware shall be [as scheduled [herein] [on the drawings]] [as specified in Section 08700 BUILDERS' HARDWARE].

2.12.2 Sliding Doors

Sliding doors shall be of the metal framed or self-framing metal type. Covering shall be of same material and finish as the siding, except heavier gauge material shall be used if required to provide rigidity. All hardware necessary for the complete installation of the doors shall be furnished. Accessories shall include galvanized steel track, brackets, permanently lubricated dual wheel trolley hangers, operating handle, slide bolt latch assembly permitting padlocking from either inside or outside of building and rubber or elastomeric weather stripping.

2.12.3 Overhead Doors Rolling Doors

Overhead rolling doors shall conform to the requirements of Section 08330 OVERHEAD ROLLING DOORS. Hardware shall be [as scheduled [herein] [on the drawings]] [as specified in Section 08700 BUILDERS' HARDWARE].

2.12.4 Sectional Overhead Doors

Sectional overhead doors shall conform to the requirements of Section 08360 SECTIONAL OVERHEAD DOORS. Hardware shall be [as scheduled [herein] [on the drawings]] [as specified in Section 08700 BUILDERS' HARDWARE].

2.12.5 Vertical Lift Doors

Vertical lift doors shall conform to the requirements of Section 08370 VERTICAL LIFT DOORS. Hardware shall be [as scheduled [herein] [on the drawings]] [as specified in Section 08700 BUILDERS' HARDWARE].

2.13 WINDOWS

Windows shall be of steel in accordance with SWI Specifier's Guide or of aluminum in accordance with AAMA 101. Windows shall be of the type shown, furnished complete with operating and locking hardware, glazing, aluminum screened panels, weather stripping, framing, and fasteners to properly install the windows.

2.14 INSULATION

****

NOTE: Heat is transferred through walls and roofs, and is either gained or lost, depending on whether a building is experiencing summer or winter conditions. Along with heat transfer concepts, moisture transfer concepts must be considered. In cold climates moisture migration can create a problem due to condensation. It is important to remember that drawings must show type, extent, and location of insulation. The vapor retarder location is dependent on the climate as noted in paragraph VAPOR RETARDER.

The required R-value for the insulation will be determined and shown at the appropriate details on the drawings. The required R-values for the insulation will never be less than the R-values used in the Energy Budget Analysis. The R-values shown on the drawings should be greater than those used in the design analysis to account for thermal bridges.

Provide about a one-third increase (or as local experience has shown, if different) in R-value over what is calculated; that is, if an R-value of 3 is needed in metric (metric units are square meter K/W) (16 in I-P with units of h x square feet x degree F/Btu) use an R-value of 4 (21) in the contract. If an analysis of thermal bridges in the design gives a requirement greater or less than this, it should be used.

Flame spread and smoke development ratings of insulation, to include facing, must comply with the requirements of MIL HDBK 1008C. Exposed insulation will be faced, mineral fiber type, only; cellular plastic insulations will not be exposed.

If prefabricated insulated sandwich panels are used for siding and roofing, delete this paragraph in its entirety.
****

Thermal resistance of insulation shall be not less than the R-values shown on the contract drawings. R-values shall be determined at a mean temperature of 75 degrees F in accordance with ASTM C 518. Insulation shall be a standard product with the insulation manufacturer, factory marked or identified with insulation manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. [Blanket insulation shall have a facing as specified in paragraph VAPOR RETARDER]. [Roof] [Roof and wall] insulation [, including facings,] shall have a flame spread not in excess of [_____] and a smoke developed rating not in excess of [_____] when tested in accordance with ASTM E 84. The stated R-value of the insulation shall be certified by an independent Registered Professional Engineer if tests are conducted in the insulation manufacturer's laboratory.

2.14.1 Rigid Board Insulation

2.14.1.1 Polyisocyanurate

Polyisocyanurate insulation shall conform to ASTM C 1289, Type I, Class 2 (having a minimum recovered material content of 9 percent by weight of core material in the polyisocyanurate portion). For impermeable faced polyisocyanurate (Ex: aluminum foil) the maximum design R-value per 1 inch of insulation used shall be 7.2 inch.

2.14.1.2 Polystyrene

Insulation shall conform to ASTM C 578, Type IV.

2.14.1.3 Mineral Fiber

Insulation shall conform to ASTM C 612.

2.14.1.4 Blanket Insulation

****
NOTE: The specified blanket insulation is a

flexible mineral fiber insulation for use at temperatures up to 176 degrees C (350 degrees F).
****

Blanket insulation shall conform to [ASTM C 991] [ASTM C 553].

2.14.1.5 Insulation Retainers

Retainers shall be type, size and design necessary to adequately hold the insulation and to provide a neat appearance. Metallic retaining members shall be nonferrous or have a nonferrous coating. Nonmetallic retaining members, including adhesives used in conjunction with mechanical retainers or at insulation seams, shall have a fire resistance classification not less than that permitted for the insulation.

2.15 SEALANT

Sealant shall be an elastomeric type containing no oil or asphalt. Exposed sealant shall be [colored to match the applicable building color] [clear] and shall cure to a rubber like consistency.

2.16 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

2.17 VAPOR RETARDER

****
NOTE: The term vapor retarder has been selected to describe the membrane used to reduce moisture vapor transmission. The location of the vapor retarder is determined by the climate and the building type.

The vapor retarder goes on the side of the insulation with the greatest vapor pressure during the course of the year; therefore it goes on the outside in a climate predominately warm, and on the inside in a climate predominately cool. The designer should determine the most appropriate application/installation of the vapor retarder based on project circumstances. See TM 5-810-1 for humid climate definition.

Detail the use of insulation on the drawings. Coordinate with Sections 07412 NON-STRUCTURAL METAL ROOFING and 07416 STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) ROOF SYSTEM vapor retarder requirements.
****

2.17.1 Vapor Retarders as Integral Facing

Insulation facing shall have a permeability of [0.1] [0.02] [_____] perm or less when tested in accordance with ASTM E 96. Facing shall be [white] [gray] [green] [of reinforced foil with a vinyl finish] [sheet vinyl] [; except that unreinforced foil with a natural finish may be used in concealed locations]. Facings and finishes shall be factory applied.

2.17.2 Vapor Retarders Separate from Insulation

Vapor retarder material shall be polyethylene sheeting conforming to the requirements of ASTM D 4397. A single ply of 10 mil polyethylene sheet; or, at the option of the Contractor, a double ply of 6 mil polyethylene sheet shall be used. A fully compatible polyethylene tape shall be provided which has equal or better water vapor control characteristics than the vapor retarder material. A cloth industrial duct tape in a utility grade shall also be provided to use as needed to protect the vapor retarder from puncturing.

2.18 SHOP PRIMING

Ferrous surfaces shall be cleaned of oil, grease, loose rust, loose mill scale, and other foreign substances and shop primed. Primer coating shall be in accordance with the manufacturer's standard system.

PART 3 EXECUTION

3.1 ERECTION

Dissimilar materials which are not compatible when contacting each other shall be insulated from each other by means of gaskets or insulating compounds. Improper or mislocated drill holes in panels shall be plugged with an oversize screw fastener and gasketed washer; however, panels with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces shall be kept clean and free from sealant, metal cuttings, excess material from thermal cutting, and other foreign materials. Exposed surfaces which have been thermally cut shall be finished smooth within a tolerance of 1/8 inch. Stained, discolored or damaged sheets shall be removed from the site. Welding of steel shall conform to AWS D1.1; welding of aluminum shall conform to AA Design Manual.

3.1.1 Framing Members and Anchor Bolts

Erection shall be in accordance with the approved erection instructions and drawings and with applicable provision of AISC Spec. Framing members fabricated or modified on site shall be saw or abrasive cut; bolt holes shall be drilled. Onsite flame cutting of framing members, with the exception of small access holes in structural beam or column webs, will not be permitted. High-strength bolting shall conform to AISC Pub No. S329 using ASTM A 325 or ASTM A 490, ASTM A 490M bolts. Improper or mislocated bolt holes in structural members or other misfits caused by improper fabrication or erection, shall be repaired in accordance with AISC Pub No. S303. Concrete work is specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Anchor bolts shall be accurately set by template while the concrete is in a plastic state. Uniform bearing under base plates and sill members shall be provided using a nonshrinking grout. Separate leveling plates under column base plates shall not be used. Members shall be accurately spaced to assure proper fitting of panels. As erection progresses, the work shall be securely fastened to resist the dead load and wind and erection stresses. Supports for electric overhead traveling cranes shall be positioned and aligned in accordance with MHI CMAA 70.

3.1.2 Roofing and Siding Installation

****

NOTE: When factory insulated panels are used, this paragraph will be modified as necessary to cover their installation.
****

Siding shall be applied with the longitudinal configurations in the vertical position. Roofing shall be applied with the longitudinal configurations in the direction of the roof slope. Accessories shall be fastened into framing members, except as otherwise approved. Closure strips shall be provided as indicated and where necessary to provide weathertight construction. Fastener and fastener spacing shall be in accordance with manufacture design.

3.1.3 Installation of Gutters and Downspouts

Gutters and downspouts shall be rigidly attached to the building. Spacing of cleats for gutters shall be 16 inches maximum. Spacing of brackets and spacers for gutters shall be 36 inches maximum. Supports for downspouts shall be spaced according to manufacturer's recommendations.

3.1.4 Louvers and Ventilators

Louvers and ventilators shall be rigidly attached to the supporting construction to assure a weather tight installation.

3.1.5 Doors and Windows

Doors and windows, including frames and hardware, shall be securely anchored to the supporting construction, shall be installed plumb and true, and shall be adjusted as necessary to provide proper operation. Joints at doors and windows shall be sealed according to manufacturer's recommendations to provide weathertight construction.

3.1.6 Insulation Installation

****
NOTE: If factory insulated panels are used for roofing and siding, delete this paragraph in its entirety.
****

Insulation shall be installed as indicated and in accordance with manufacturer's instructions.

3.1.6.1 Board Insulation with Blanket Insulation

Rigid or semirigid board insulation shall be laid in close contact. If more than one layer of insulation is required, joints in the second layer shall be offset from joints in the first layer. A layer of blanket insulation shall be placed over the rigid or semirigid board insulation to be compressed against the underside of the metal roofing to reduce thermal bridging, dampen noise, and prevent roofing flutter. This layer of blanket insulation shall be compressed a minimum of 50 percent.

3.1.6.2 Blanket Insulation

Blanket insulation shall be installed over the purlins and held tight against the metal roofing. It shall be supported by an integral facing or other commercially available support system.

3.1.7 Vapor Retarder Installation

****
NOTE: Choose one paragraph and delete the other.
****

3.1.7.1.1 Integral Facing on Blanket Insulation

Integral facing on blanket insulation shall have the facing lapped and sealed with a compatible tape to provide a vapor tight membrane.

3.2 Polyethylene Vapor Retarder

The polyethylene vapor retarder membrane shall be installed over the entire surface. A fully compatible polyethylene tape shall be used to seal the edges of the sheets to provide a vapor tight membrane. Sheet edges shall be lapped not less than 6 inches. Sufficient material shall be provided to avoid inducing stresses in the sheets due to stretching or binding. All tears or punctures that are visible in the finished surface at any time during the construction process shall be sealed with polyethylene tape.

3.3 Wall Liner

Wall liner shall be securely fastened into place in accordance with the manufacturer's recommendation and in a manner to present a neat appearance.

3.4 FIELD PAINTING

****
NOTE: Field painting covers touch-up painting of previously painted surfaces and finish painting of steel doors and steel windows. Additional requirements will be added as necessary to cover finish painting of wood doors and other items requiring a field applied paint finish. When required, field color finish will be specified in accordance with Section 09900 PAINTING, GENERAL.
****

Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire brushed and touched up with the same material used for the shop coat. Shop-primed ferrous surfaces exposed on the outside of the building and all shop-primed surfaces of doors and windows shall be painted with two coats of an approved exterior enamel. Factory color finished surfaces shall be touched up as necessary with the manufacturer's recommended touch-up paint.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM

FACILITY
DESCRIPTION:____

BUILDING
NUMBER:____

CORPS OF ENGINEERS CONTRACT
NUMBER:____

CONTRACTOR

CONTRACTOR:____
ADDRESS:____

POINT OF
CONTACT:____

TELEPHONE
NUMBER:____

OWNER

OWNER:____

ADDRESS:____

POINT OF
CONTACT:____

TELEPHONE
NUMBER:____

CONSTRUCTION AGENT

CONSTRUCTION
AGENT:____
ADDRESS:____

POINT OF CONTACT:____

TELEPHONE
NUMBER:____

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(continued)

THE METAL BUILDING SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY [_____] FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCIES, WIND DAMAGE AND STRUCTURAL FAILURE WITHIN PROJECT SPECIFIED DESIGN LOADS, AND LEAKAGE. THE METAL BUILDING SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE, BUT SHALL NOT BE LIMITED TO, THE FOLLOWING: FRAMING AND STRUCTURAL MEMBERS, ROOFING AND SIDING PANELS AND SEAMS, INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS, ACCESSORIES, TRIM, FLASHINGS AND MISCELLANEOUS BUILDING CLOSURE ITEMS SUCH AS DOORS AND WINDOWS (WHEN FURNISHED BY THE MANUFACTURER), CONNECTORS, COMPONENTS, AND FASTENERS, AND OTHER SYSTEM COMPONENTS AND ASSEMBLIES INSTALLED TO PROVIDE A WEATHERTIGHT SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THESE SPECIFICATIONS THAT BECOME PART OF THE METAL BUILDING SYSTEM. ALL MATERIAL AND WORKMANSHIP DEFICIENCIES, SYSTEM DETERIORATION CAUSED BY EXPOSURE TO THE ELEMENTS AND/OR INADEQUATE RESISTANCE TO SPECIFIED SERVICE DESIGN LOADS, WATER LEAKS AND WIND UPLIFT DAMAGE SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE AND LEAKAGE ASSOCIATED WITH THE METAL BUILDING SYSTEM COVERED UNDER THIS WARRANTY SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON [_____] AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

____

(Company President)   (Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(continued)

THE CONTRACTOR SHALL SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE METAL BUILDING SYSTEM, WHICH SHALL BE SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR WILL BE ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE BUILDING SYSTEM DUE TO ACTIONS BY THE OWNER WHICH INHIBIT FREE DRAINAGE FROM THE ROOF, AND GUTTERS AND DOWNSPOUTS; OR CONDITIONS WHICH CREATE PONDING WATER ON THE ROOF OR AGAINST THE BUILDING SIDING.

6. THIS WARRANTY APPLIES TO THE METAL BUILDING SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES. REPORTS OF LEAKS AND BUILDING SYSTEM DEFICIENCIES SHALL BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE BY TELEPHONE OR IN WRITING FROM EITHER THE OWNER, OR CONTRACTING OFFICER. EMERGENCY REPAIRS, TO PREVENT FURTHER ROOF LEAKS, SHALL BE INITIATED IMMEDIATELY; A WRITTEN PLAN SHALL BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS SSSMR SYSTEM WITHIN SEVEN CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT SHALL BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED

IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE METAL BUILDING SYSTEM REPLACED OR REPAIRED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR. IN THE EVENT THE CONTRACTOR DISPUTES THE EXISTENCE OF A WARRANTABLE DEFECT, THE CONTRACTOR MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION, UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. THE REQUEST FOR AN ARBITRATOR MUST BE MADE WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED THE PARTIES SHALL, WITHIN 10 DAYS JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES SHALL CONFER WITHIN 10 DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE NAME REMAINS. THE REMAINING PERSON SHALL BE THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED ETC., SHALL BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT SHALL PAY FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. A WRITTEN ARBITRATOR'S DECISION WILL BE REQUESTED NOT LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT. A FRAMED COPY OF THIS WARRANTY SHALL BE POSTED IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS

CEGS-13280 (May 1998)

Superseding
CEGS-02080 (January 1997)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

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05/98

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DEPARTMENT OF THE ARMY **CEGS-13280 (May 1998)**
U.S. ARMY CORPS OF ENGINEERS **-------------------------**
Superseding
CEGS-02080 (January 1997)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 13280

ASBESTOS ABATEMENT
05/98

****
NOTE: This guide specification covers the requirements for removal, encapsulation, encasement, enclosure or repair of friable and nonfriable asbestos-containing material during the demolition, alteration, renovation, or maintenance of structures, substrates, equipment or portions thereof that contain asbestos; and transportation, disposal, storage, containment of, and housekeeping activities on the site at which these activities are performed. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: This specification includes asbestos abatement activities and requirements in accordance with 40 CFR Part 61, Subpart M (USEPA); Class I, Class II, Class III, and Class IV abatement operations per 29 CFR 1926, .1101(OSHA); training requirements in accordance with OSHA 29 CFR 1926, .1101 and 40 CFR 763 (USEPA); selectable optional air monitoring requirements in accordance with 40 CFR 763; and is supplemented by Engineer Pamphlet

(EP) 1110-1-11, "Asbestos Abatement Guideline Detail Sheets". This specification has been developed to be used with a comprehensive set of Asbestos Abatement Detail Sheets in EP 1110-1-11. The EP provides guidance instructions on the selection and use of 2 types of Detail Sheets: SET-UP DETAILS (describing the containment and control methods to be used) and RESPONSE ACTION DETAILS (describing the abatement technique to be employed (removal, encapsulation, encasement, enclosure or repair) and the specific work task item to be abated (ex. removal of acoustical ceiling plaster)). Each RESPONSE ACTION DETAIL references the applicable SET-UP DETAIL to be used. All Detail Sheets are identified by numeric designation. Each individual asbestos abatement work task, to include pertinent information for the task and the appropriate Detail Sheets, will be summarized at paragraph DESCRIPTION OF WORK, Table 1, and will not have to be repeated in this paragraph.

The material and equipment required for each project are very dependent upon the abatement containment and control requirements (SET-UP DETAILS) and the abatement technique to be used (RESPONSE ACTION DETAIL). Edit the materials and equipment paragraphs accordingly. Ensure that all necessary materials and equipment are specified.

The limits of asbestos abatement must be indicated on project drawings and in the specification in sufficient detail for the Contractor to submit an accurate bid. In addition, the project drawings will clearly show the asbestos abatement information required on the Note to paragraph DESCRIPTION OF WORK for Table 1, and where the limits of asbestos abatement will impact non-asbestos abatement work activities or interface with new work.

Demolition and/or renovation of structures that contain nonfriable Category I or II ACM that would be left in place during demolition is governed by 40 CFR Part 61, Subpart M and state requirements. The USEPA has published guidance documents that will assist in this decision process. They include EPA 340/1-92-010(1992), "Guidelines for Catastrophic Emergency Situations Involving Asbestos"; 340/1-92-013(1992), "A Guide to Normal Demolition Practices Under the Asbestos NESHAP"; and EPA document dated 1994, "Asbestos/NESHAP Demolition Decision Tree". Consult with the USEPA regional office, USEPA regulations, state regulator and state requirements, and the Army guidance referenced in EP 1110-1-11 for the specific survey, assessment and

decision steps to take prior to making a decision to leave nonfriable ACM in-place during building demolition, or to remove it prior to demolition. Friable ACM shall always be removed prior to any building demolition.

The USEPA has delegated the responsibility of approving landfills for the disposal of asbestos to most states. Verify with the state in which the project is located whether the state, USEPA, region, or local agency has jurisdiction and what the requirements are.

For OSHA Class I asbestos abatement operations that involve the abatement of less than 1 square meter (10 square feet) or 8 linear meters (25 linear feet); Class II operations; Class III operations; or outdoor abatement operations; an enclosed containment regulated area (to include full containment, single or double bulkhead containment, or mini-containment) may not be required. The location of the item to be abated, type of material, and potential hazard must be reviewed and a judgment made by the designer as to whether or not a modified containment area, glovebag, or outdoor technique may be safely used. In a case where an enclosed containment regulated area is not required, many of the provisions in this specification should be deleted.

Confer with the Contracting Officer to determine if a special clause will be prepared and included for Contractor pre-qualification (see EP 1110-1-11) requirements.

The designer will not specify the use of any replacement material that contains asbestos.
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1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided in the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z9.2 (1979; R 1991) Fundamentals Governing the

	Design and Operation of Local Exhaust Systems
ANSI Z87.1	(1989; Errata; Z87.1a) Occupational and Educational Eye and Face Protection
ANSI Z88.2	(1992) Respiratory Protection

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 732	(1995) Aging Effects of Artificial Weathering on Latex Sealants
ASTM D 522	(1993a) Mandrel Bend Test of Attached Organic Coatings
ASTM D 1331	(1989; R 1995) Surface and Interfacial Tension of Solutions of Surface-Active Agents
ASTM D 2794	(1993) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 4397	(1996) Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM E 119	(1995a) Fire Tests of Building Construction and Materials
ASTM E 736	(1992) Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
ASTM E 1368	(1997) Visual Inspection of Asbestos Abatement Projects

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1926	Safety and Health Regulations for Construction
40 CFR 61	National Emissions Standards for Hazardous Air Pollutants
40 CFR 763	Asbestos
42 CFR 84	Approval of Respiratory Protective Devices
49 CFR 107	Hazardous Materials Program Procedures

49 CFR 171	General Information, Regulations and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7	(1990) Compressed Air for Human Respiration
CGA G-7.1	(1989) Commodity Specification for Air

ENGINEERING MANUALS (EM)

EM 385-1-1	(1996) Safety and Health Requirements Manual

ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 340/1-90-018	(1990) Asbestos/NESHAP Regulated Asbestos Containing Materials Guidance
EPA 340/1-90-019	(1990) Asbestos/NESHAP Adequately Wet Guidance
EPA 560/5-85-024	(1985) Guidance for Controlling Asbestos-Containing Materials in Buildings

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(1996) Methods of Fire Test for Flame-Resistant Textiles and Films

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH Pub No. 84-100	(1984; Supple 1985, 1987, 1988 & 1990) NIOSH Manual of Analytical Methods

UNDERWRITERS LABORATORIES (UL)

UL 586	(1996) High-Efficiency, Particulate, Air Filter Units

1.2 DEFINITIONS

a. Adequately Wet: A term defined in 40 CFR 61, Subpart M, and EPA 340/1-90-019 meaning to sufficiently mix or penetrate with liquid to prevent the release of particulate. If visible emissions are observed coming from asbestos-containing material (ACM), then that material has not been adequately wetted. However, the absence of visible emissions is not sufficient evidence of being adequately wetted.

b. Aggressive Method: Removal or disturbance of building material by sanding, abrading, grinding, or other method that breaks, crumbles, or disintegrates intact asbestos-containing material (ACM).

c. Amended Water: Water containing a wetting agent or surfactant with a surface tension of at least 29 dynes per square centimeter when tested in accordance with ASTM D 1331.

d. Asbestos: Asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophylite asbestos, actinolite asbestos, and any of these minerals that have been chemically treated and/or altered.

e. Asbestos-Containing Material (ACM): Any materials containing more than one percent asbestos.

f. Asbestos Fiber: A particulate form of asbestos, 5 micrometers or longer, with a length-to-width ratio of at least 3 to 1.

g. Authorized Person: Any person authorized by the Contractor and required by work duties to be present in the regulated areas.

h. Building Inspector: Individual who inspects buildings for asbestos and has EPA Model Accreditation Plan (MAP) "Building Inspector" training; accreditation required by 40 CFR 763, Subpart E, Appendix C.

i. Certified Industrial Hygienist (CIH): An Industrial Hygienist certified in the practice of industrial hygiene by the American Board of Industrial Hygiene.

j. Class I Asbestos Work: Activities defined by OSHA involving the removal of thermal system insulation (TSI) and surfacing ACM.

k. Class II Asbestos Work: Activities defined by OSHA involving the removal of ACM which is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos- containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastic. Certain "incidental" roofing materials such as mastic, flashing and cements when they are still intact are excluded from Class II asbestos work. Removal of small amounts of these materials which would fit into a glovebag may be classified as a Class III job.

l. Class III Asbestos Work: Activities defined by OSHA that involve repair and maintenance operations, where ACM, including TSI and surfacing ACM, is likely to be disturbed. Operations may include drilling, abrading, cutting a hole, cable pulling, crawling through tunnels or attics and spaces above the ceiling, where asbestos is actively disturbed or asbestos-containing debris is actively disturbed.

m. Class IV Asbestos Work: Maintenance and custodial construction activities during which employees contact but do not disturb ACM and activities to clean-up dust, waste and debris resulting from Class I, II, and III activities. This may include dusting surfaces where ACM waste and debris and accompanying dust exists and cleaning up loose ACM debris from TSI or surfacing ACM following construction.

n. Clean room: An uncontaminated room having facilities for the storage of employees' street clothing and uncontaminated materials and equipment.

o. Competent Person: In addition to the definition in 29 CFR 1926, Section .32(f), a person who is capable of identifying existing asbestos hazards as defined in 29 CFR 1926, Section .1101, selecting the appropriate control strategy, has the authority to take prompt corrective measures to eliminate them and has EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training; accreditation required by 40 CFR 763, Subpart E, Appendix C.

p. Contractor/Supervisor: Individual who supervises asbestos abatement work and has EPA Model Accreditation Plan "Contractor/Supervisor" training; accreditation required by 40 CFR 763, Subpart E, Appendix C.

q. Critical Barrier: One or more layers of plastic sealed over all openings into a regulated area or any other similarly placed physical barrier sufficient to prevent airborne asbestos in a regulated area from migrating to an adjacent area.

r. Decontamination Area: An enclosed area adjacent and connected to the regulated area and consisting of an equipment room, shower area, and clean room, which is used for the decontamination of workers, materials, and equipment that are contaminated with asbestos.

s. Demolition: The wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of asbestos products.

t. Disposal Bag: A 6 mil thick, leak-tight plastic bag, pre-labeled in accordance with 29 CFR 1926, Section .1101, used for transporting asbestos waste from containment to disposal site.

u. Disturbance: Activities that disrupt the matrix of ACM, crumble or pulverize ACM, or generate visible debris from ACM. Disturbance includes cutting away small amounts of ACM, no greater than the amount which can be contained in 1 standard sized glovebag or waste bag, not larger than 60 inches in length and width in order to access a building component.

v. Equipment Room or Area: An area adjacent to the regulated area used for the decontamination of employees and their equipment.

w. Employee Exposure: That exposure to airborne asbestos that would occur if the employee were not using respiratory protective equipment.

x. Fiber: A fibrous particulate, 5 micrometers or longer, with a length to width ratio of at least 3 to 1.

y. Friable ACM: A term defined in 40 CFR 61, Subpart M and EPA 340/1-90-018 meaning any material which contains more than 1 percent asbestos, as determined using the method specified in 40 CFR 763, Subpart E, Appendix A, Section 1, Polarized Light Microscopy (PLM), that when dry, can be crumbled, pulverized, or reduced to powder by hand pressure. If the asbestos content is less than 10 percent, as determined by a method other than point counting by PLM, the asbestos content is verified by point counting using PLM.

z. Glovebag: Not more than a 60 by 60 inch impervious plastic bag-like enclosure affixed around an asbestos-containing material, with glove-like appendages through which material and tools may be handled.

aa. High-Efficiency Particulate Air (HEPA) Filter: A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 micrometers in diameter.

bb. Homogeneous Area: An area of surfacing material or thermal system insulation that is uniform in color and texture.

cc. Industrial Hygienist: A professional qualified by education, training, and experience to anticipate, recognize, evaluate, and develop controls for occupational health hazards.

dd. Intact: ACM which has not crumbled, been pulverized, or otherwise deteriorated so that the asbestos is no longer likely to be bound with its matrix. Removal of "intact" asphaltic, resinous, cementitious products does not render the ACM non-intact simply by being separated into smaller pieces.

ee. Model Accreditation Plan (MAP): USEPA training accreditation requirements for persons who work with asbestos as specified in 40 CFR 763, Subpart E, Appendix C.

ff. Modification: A changed or altered procedure, material or component of a control system, which replaces a procedure, material or component of a required system.

gg. Negative Exposure Assessment: A demonstration by the Contractor to show that employee exposure during an operation is expected to be consistently below the OSHA Permissible Exposure Limits (PELs).

hh. NESHAP: National Emission Standards for Hazardous Air Pollutants. The USEPA NESHAP regulation for asbestos is at 40 CFR 61, Subpart M.

ii. Nonfriable ACM: A NESHAP term defined in 40 CFR 61, Subpart M and EPA 340/1-90-018 meaning any material containing more than 1 percent asbestos, as determined using the method specified in 40 CFR 763, Subpart E, Appendix A, Section 1, Polarized Light Microscopy, that, when dry, cannot be crumbled, pulverized or reduced to powder by hand pressure.

jj. Nonfriable ACM (Category I): A NESHAP term defined in 40 CFR 61, Subpart E and EPA 340/1-90-018 meaning asbestos-containing packings, gaskets, resilient floor covering, and asphalt roofing products containing more than 1 percent asbestos as determined using the method specified in 40 CFR 763, Subpart F, Appendix A, Section 1, Polarized Light Microscopy.

kk. Nonfriable ACM (Category II): A NESHAP term defined in 40 CFR 61, Subpart E and EPA 340/1-90-018 meaning any material, excluding

Category I nonfriable ACM, containing more than 1 percent asbestos, as determined using the methods specified in 40 CFR 763, Subpart F, Appendix A, Section 1, Polarized Light Microscopy, that when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

ll. Permissible Exposure Limits (PELs):

(1) PEL-Time weighted average(TWA): Concentration of asbestos not in excess of 0.1 fibers per cubic centimeter of air (f/cc) as an 8 hour time weighted average (TWA), as determined by the method prescribed in 29 CFR 1926, Section .1101, Appendix A, or the current version of NIOSH Pub No. 84-100 analytical method 7400.

(2) PEL-Excursion Limit: An airborne concentration of asbestos not in excess of 1.0 f/cc of air as averaged over a sampling period of 30 minutes as determined by the method prescribed in 29 CFR 1926, Section .1101, Appendix A, or the current version of NIOSH Pub No. 84-100 analytical method 7400.

mm. Regulated Area: An OSHA term defined in 29 CFR 1926, Section .1101 meaning an area established by the Contractor to demarcate areas where Class I, II, and III asbestos work is conducted; also any adjoining area where debris and waste from such asbestos work accumulate; and an area within which airborne concentrations of asbestos exceed, or there is a reasonable possibility they may exceed, the permissible exposure limit.

nn. Removal: All operations where ACM is taken out or stripped from structures or substrates, and includes demolition operations.

oo. Repair: Overhauling, rebuilding, reconstructing, or reconditioning of structures or substrates, including encapsulation or other repair of ACM attached to structures or substrates. If the amount of asbestos so "disturbed" cannot be contained in 1 standard glovebag or waste bag, Class I precautions are required.

pp. Spills/Emergency Cleanups: Cleanup of sizable amounts of asbestos waste and debris which has occurred, for example, when water damage occurs in a building, and sizable amounts of ACM are dislodged. A Competent Person evaluates the site and ACM to be handled, and based on the type, condition and extent of the dislodged material, classifies the cleanup as Class I, II, or III. Only if the material was intact and the cleanup involves mere contact of ACM, rather than disturbance, could there be a Class IV classification.

qq. Surfacing ACM: Asbestos-containing material which contains more than 1% asbestos and is sprayed-on, troweled-on, or otherwise applied to surfaces, such as acoustical plaster on ceilings and fireproofing materials on structural members, or other materials on surfaces for acoustical, fireproofing, or other purposes.

rr. Thermal system insulation (TSI) ACM: ACM which contains more than 1% asbestos and is applied to pipes, fittings, boilers, breeching, tanks, ducts, or other interior structural components to prevent heat loss or gain or water condensation.

ss. Transite: A generic name for asbestos cement wallboard and pipe.

tt. Worker: Individual (not designated as the Competent Person or a supervisor) who performs asbestos work and has completed asbestos worker training required by 29 CFR 1926, Section .1101, to include EPA Model Accreditation Plan (MAP) "Worker" training; accreditation required by 40 CFR 763, Subpart E, Appendix C, if required by the OSHA Class of work to be performed or by the state where the work is to be performed.

1.3 DESCRIPTION OF WORK

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NOTE: Review the Notes under PART 1 GENERAL. For each individual ACM abatement work task, consult with the customer, review EP 1110-1-11 and enter the required work task data on Table 1, at the end of this Section, as described in the Notes section of the Table. There will be one data sheet for each abatement work task. Attach to each work task data sheet the selected Response Action Detail Sheet and its referenced Set-up Detail Sheets. Select applicable bracketed items in this section.

Discovery of Unexpected Asbestos: Suspect asbestos containing material that is discovered during demolition (in particular buildings constructed no later than 1980), which was previously inaccessible, must be sampled and analyzed for its asbestos content. The designer should anticipate additional sampling and analysis. The number of additional samples should be based on the extent of demolition and previous survey data. Insert the number of bulk samples anticipated in the bracket in paragraph Unexpected Discovery of Asbestos. Sampling activities undertaken to determine the presence of additional ACM should be conducted by personnel who have successfully completed the EPA Model Accreditation (MAP) "Building Inspector" course required by 40 CFR 763, Subpart E, Appendix C.

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The work covered by this section includes the [removal] [encapsulation] [encasement] [enclosure] [repair] of asbestos-containing materials (ACM) which are encountered during [demolition] [alteration] [maintenance] [renovation] [spill/emergency cleanup] [housekeeping] activities associated with this project and describes procedures and equipment required to protect workers and occupants of the regulated area from contact with airborne asbestos fibers and ACM dust and debris. Activities include OSHA [Class I] [Class II] [Class III] [Class IV] work operations involving ACM. The work also includes containment, storage, transportation and disposal of the generated ACM wastes. More specific operational procedures shall be detailed in the required Accident Prevention Plan and its subcomponents, the Asbestos Hazard Abatement Plan and Activity Hazard Analyses required in paragraph SAFETY AND HEALTH PROGRAM AND PLANS.

1.3.1 Abatement Work Tasks

The specific ACM to be abated is identified on the detailed plans and project drawings. A summary of work task data elements for each individual ACM abatement work task to include the appropriate RESPONSE ACTION DETAIL SHEET (item to be abated and methods to be used) and SET-UP DETAIL SHEETS (containment techniques to include safety precautions and methods) is included in Table 1, "Individual Work Task Data Elements" at the end of this section.

1.3.2 Unexpected Discovery of Asbestos

For any previously untested building components suspected to contain asbestos and located in areas impacted by the work, the Contractor shall notify the Contracting Officer (CO) who will have the option of ordering up to [_____] bulk samples to be obtained at the Contractor's expense and delivered to a laboratory accredited under the National Institute of Standards and Technology (NIST) "National Voluntary Laboratory Accreditation Program (NVLAP)" and analyzed by PLM at no additional cost to the Government. Any additional components identified as ACM that have been approved by the Contracting Officer for removal shall be removed by the Contractor and will be paid for by an equitable adjustment to the contract price under the CONTRACT CLAUSE titled "changes". Sampling activities undertaken to determine the presence of additional ACM shall be conducted by personnel who have successfully completed the EPA Model Accreditation Plan (MAP) "Building Inspector" training course required by 40 CFR 763, Subpart E, Appendix C.

1.4 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required. The designer will consult with the District Engineering, Construction and Safety, and Occupational Health offices in making each submittal classification determination.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval and "FIO" when the submittal is for information only.

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Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Materials and Equipment; FIO.

Manufacturer's catalog data for all materials and equipment to be used in the work, including brand name, model, capacity, performance characteristics and any other pertinent information. Test results and certificates from the manufacturer of encapsulants substantiating compliance with performance requirements of this specification. Material Safety Data Sheets for all chemicals to be used onsite in the same format as implemented in the Contractor's HAZARD COMMUNICATION PROGRAM. Data shall include, but shall not be limited to, the following items:

a. High Efficiency Filtered Air (HEPA) local exhaust equipment

b. Vacuum cleaning equipment

c. Pressure differential monitor for HEPA local exhaust equipment

d. Air monitoring equipment

e. Respirators

f. Personal protective clothing and equipment

   (1) Coveralls
   (2) Underclothing
   (3) Other work clothing
   (4) Foot coverings
   (5) Hard hats
   (6) Eye protection
   (7) Other items required and approved by Contractors Designated IH and Competent Person

g. Glovebag

h. Duct Tape

i. Disposal Containers

   (1) Disposal bags
   (2) Fiberboard drums
   (3) Paperboard boxes

j. Sheet Plastic

   (1) Polyethylene Sheet - General
   (2) Polyethylene Sheet - Flame Resistant
   (3) Polyethylene Sheet - Reinforced

k. Wetting Agent

   (1) Amended Water
   (2) Removal encapsulant

l. Strippable Coating

m. Prefabricated Decontamination Unit

n. Other items

o. Chemical encapsulant

p. Chemical encasement materials

q. Material Safety Data Sheets (for all chemicals proposed)

SD-04 Drawings

Site Layout; GA.

Descriptions, detail project drawings, and site layout to include worksite containment area techniques as prescribed on applicable SET-UP DETAIL SHEETS, local exhaust ventilation system locations, decontamination and load-out units, other temporary waste storage facility, access tunnels, location of temporary utilities (electrical, water, sewer) and boundaries of each regulated area.

SD-08 Statements

Qualifications; GA.

A written report providing evidence of qualifications for personnel, facilities and equipment assigned to the work.

Training Program; FIO.

A copy of the written project site-specific training material as indicated in 29 CFR 1926, Section .1101 that will be used to train onsite employees. The training document shall be signed by the Contractor's Designated IH and Competent Person.

Medical Requirements; FIO.

Physician's written opinion.

Encapsulants; GA.

Certificates stating that encapsulants meet the applicable specified performance requirements.

SD-09 Reports

Exposure Assessment and Air Monitoring; GA.

Initial exposure assessments, negative exposure assessments, air-monitoring results and documentation.

Local Exhaust Ventilation; FIO.

Pressure differential recordings.

Licenses, Permits and Notifications; GA.

Licenses, permits, and notifications.

SD-13 Certificates

Vacuum, Filtration and Ventilation Equipment; FIO.

Manufacturer's certifications showing compliance with ANSI Z9.2 for:

a. Vacuums.

b. Water filtration equipment.

c. Ventilation equipment.

d. Other equipment required to contain airborne asbestos fibers.

SD-18 Records

Respiratory Protection Program; GA.

Records of the respirator program.

Cleanup and Disposal; GA.

Waste shipment records. Weigh bills and delivery tickets shall be furnished for information only.

1.5 QUALIFICATIONS

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NOTE: Normal practice is to have the Contractor hire 1 independent Industrial Hygienist (Contractor's Designated IH) to perform all required functions. However, some applicable laws forbid this approach and will dictate when the Contractor's Designated IH, the Contracting Officer's Designated IH or both will be required to perform the function involved. However, the Contractor will always hire an IH.

Check federal, state, and local requirements for qualifications and experience of the Contractor's Designated IH, Designated Competent Person, supervisor, and workers. Check customer requirements. Edit this paragraph accordingly.

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1.5.1 Written Qualifications and Organization Report

The Contractor shall furnish a written qualifications and organization report providing evidence of qualifications of the Contractor, Contractor's Project Supervisor, Designated Competent Person, supervisors and workers; Designated IH (person assigned to project and firm name); independent testing laboratory (including name of firm, principal, and analysts who will perform analyses); all subcontractors to be used including disposal transportation and disposal facility firms, subcontractor supervisors, subcontractor workers; and any others assigned to perform asbestos abatement and support activities. The report shall include an organization chart showing the Contractor's staff organization for this project by name and title, chain of command and reporting relationship with all subcontractors. The report shall be signed by the Contractor, the Contractor's onsite project manager, Designated Competent Person, Designated IH, designated testing laboratory and the principals of all subcontractors to be used. The Contractor shall include the following statement in the report: "By signing this report I certify that the personnel I am responsible for during the course of this project fully understand the contents of 29 CFR 1926, Section .1101, 40 CFR 61, Subpart M, and the federal, state and local requirements specified in paragraph SAFETY AND HEALTH PROGRAM AND PLANS for those asbestos abatement activities that they will be involved in."

1.5.2 Specific Requirements

The Contractor shall designate in writing, personnel meeting the following qualifications:

a. Designated Competent Person: The name, address, telephone number, and resume of the Contractor's Designated Competent Person shall be provided. Evidence that the full-time Designated Competent Person is qualified in accordance with 29 CFR 1926, Sections .32 and .1101, has EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training accreditation required by 40 CFR 763, Subpart E, Appendix C, and is experienced in the administration and supervision of asbestos abatement projects, including exposure assessment and monitoring, work practices, abatement methods, protective measures for personnel, setting up and inspecting asbestos abatement work areas, evaluating the integrity of containment barriers, placement and operation of local exhaust systems, ACM generated waste containment and disposal procedures, decontamination units installation and maintenance requirements, site safety and health requirements, notification of other employees onsite, etc. The duties of the Competent Person shall include the following: controlling entry to and exit from the regulated area; supervising any employee exposure monitoring required by 29 CFR 1926, Section .1101; ensuring that all employees working within a regulated area wear the appropriate personal protective equipment (PPE), are trained in the use of appropriate methods of exposure control, and use the hygiene facilities and decontamination procedures specified; and ensuring that engineering controls in use are in proper operating conditions and are functioning properly. The Designated Competent Person shall be responsible for compliance with applicable federal, state and local requirements, the Contractor's Accident Prevention Plan and Asbestos Hazard Abatement Plan. The Designated Competent Person shall provide, and the Contractor shall submit, the "Contractor/Supervisor" course completion certificate and the most recent certificate for required refresher training with the employee "Certificate of Worker Acknowledgment" required by this paragraph. The Contractor shall submit evidence that this person has a minimum of [2 years] [_____] of on-the-job asbestos abatement experience relevant to OSHA competent person requirements. The Designated Competent Person shall be onsite at all times during the conduct of this project.

b. Project and Other Supervisors: The Contractor shall provide the name, address, telephone number, and resume of the Project Supervisor and other supervisors who have responsibility to implement the Accident Prevention Plan, including the Asbestos Hazard Abatement Plan and Activity Hazard Analyses, the authority to direct work performed under this contract and verify compliance, and have EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training accreditation required by 40 CFR 763, Subpart E, Appendix C. The Project Supervisor and other supervisors shall provide, and the Contractor shall submit, the "Contractor/Supervisor" course completion certificate and the most recent certificate for required refresher training with the employee "Certificate of Worker Acknowledgment" required by this paragraph. The Contractor shall submit evidence that the Project Supervisor has a minimum of [2 years] [_____] of on-the-job asbestos abatement experience relevant to project supervisor responsibilities and the other supervisors have a minimum of [1 year] [_____] on-the-job asbestos abatement experience commensurate with the responsibilities they will have on this project.

c. Designated Industrial Hygienist: The Contractor shall provide the name, address, telephone number, resume and other information specified below for the Industrial Hygienist (IH) selected to prepare the Contractor's Asbestos Hazard Abatement Plan, prepare and perform training, direct air monitoring and assist the Contractor's Competent Person in implementing and ensuring that safety and health requirements are complied with during the performance of all required work. The Designated IH shall be a person who is [board certified in the practice of industrial hygiene] [or] [board eligible (meets all education and experience requirements)] as determined and documented by the American Board of Industrial Hygiene (ABIH), has EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training accreditation required by 40 CFR 763, Subpart E, Appendix C, and has a minimum of [2 years] [_____] of comprehensive experience in planning and overseeing asbestos abatement activities. The Designated IH shall provide, and the Contractor shall submit, the "Contractor/Supervisor" course completion certificate and the most recent certificate for required refresher training with the employee "Certificate of Worker Acknowledgment" required by this paragraph. The Designated IH shall be completely independent from the Contractor according to federal, state, or local regulations; that is, shall not be a Contractor's employee or be an employee or principal of a firm in a business relationship with the Contractor negating such independent status. A copy of the Designated IH's current valid ABIH [certification] [confirmation of eligibility in writing from the ABIH] shall be included. The Designated IH shall [be onsite at all times] [visit the site at least [_____] per [month] [week]] for the duration of asbestos activities and shall be available for emergencies. In addition, the Designated IH shall prepare, and the Contractor shall submit, the name, address, telephone numbers and resumes of additional IH's and industrial hygiene technicians (IHT) who will be assisting the Designated IH in performing onsite tasks. IHs and IHTs supporting the Designated IH shall have a minimum of [2 years] [_____] of practical onsite asbestos abatement experience. The formal reporting relationship between the Designated IH and the support IHs and IHTs, the Designated Competent Person, and the Contractor shall be indicated.

d. Asbestos Abatement Workers: Asbestos abatement workers shall meet the requirements contained in 29 CFR 1926, Section .1101, 40 CFR 61, Subpart M, and other applicable federal, state and local requirements. Worker training documentation shall be provided as required on the "Certificate of Workers Acknowledgment" in this paragraph.

e. Worker Training and Certification of Worker Acknowledgment: Training documentation will be required for each employee who will perform OSHA Class I, Class II, Class III, or Class IV asbestos abatement operations. Such documentation shall be submitted on a Contractor generated form titled "Certificate of Workers Acknowledgment", to be completed for each employee in the same format and containing the same information as the example certificate at the end of this section. Training course completion certificates (initial and most recent update refresher) required by the information checked on the form shall be attached.

f. Physician: The Contractor shall provide the name, medical qualifications, address, telephone number and resume of the physician who will or has performed the medical examinations and evaluations of the persons who will conduct the asbestos abatement work tasks. The physician shall be currently licensed by the state where the workers will be or have been examined, have expertise in pneumoconiosis and shall be responsible for the determination of medical surveillance protocols and for review of examination/test results performed in compliance with 29 CFR 1926, Section .1101 and paragraph MEDICAL REQUIREMENTS. The physician shall be familiar with the site's hazards and the scope of this project.

g. First Aid and CPR Trained Persons: The names of at least 2 persons who are currently trained in first aid and CPR by the American Red Cross or other approved agency shall be designated and shall be onsite at all times during site operations. They shall be trained in universal precautions and the use of PPE as described in the Bloodborne Pathogens Standard of 29 CFR 1910, Section .1030 and shall be included in the Contractor's Bloodborne Pathogen Program. These persons may perform other duties but shall be immediately available to render first aid when needed. A copy of each designated person's current valid First Aid and CPR certificate shall be provided.

h. Independent Testing Laboratory: The Contractor shall provide the name, address and telephone number of the independent testing laboratory selected to perform the sample analyses and report the results. The testing laboratory shall be completely independent from the Contractor as recognized by federal, state or local regulations. Written verification of the following criteria, signed by the testing laboratory principal and the Contractor, shall be submitted:

(1) Phase contrast microscopy (PCM): The laboratory is fully equipped and proficient in conducting PCM of airborne samples using the methods specified by 29 CFR 1926, Section .1101, OSHA method ID-160, the most current version of NIOSH Pub No. 84-100 Method 7400, and NIOSH Pub No. 84-100 Method 7402, transmission electron microscopy (TEM); the laboratory is currently judged proficient (classified as acceptable) in counting airborne asbestos samples by PCM by successful participation in each of the last 4 rounds in the American Industrial Hygiene Association (AIHA) Proficiency Analytical Testing (PAT) Program; the names of the selected microscopists who will analyze airborne samples by PCM with verified documentation of their proficiency to conduct PCM analyses by being judged proficient in counting samples as current participating analysts in the AIHA PAT Program, and having successfully completed the Asbestos Sampling and Analysis course (NIOSH 582 or equivalent) with a copy of course completion certificate provided; when the PCM analysis is to be conducted onsite, documentation shall be provided certifying that the onsite analyst meets the same requirements.

(2) Polarized light microscopy (PLM): The laboratory is fully

equipped and proficient in conducting PLM analyses of suspect ACM bulk samples in accordance with 40 CFR 763, Subpart E, Appendix E; the laboratory is currently accredited by NIST under the NVLAP for bulk asbestos analysis and will use analysts (names shall be provided) with demonstrated proficiency to conduct PLM to include its application to the identification and quantification of asbestos content.

(3) Transmission electron microscopy (TEM): The laboratory is [fully equipped and proficient in conducting TEM analysis of airborne samples using the mandatory method specified by 40 CFR 763, Subpart E, Appendix E; the laboratory is currently accredited by NIST under the NVLAP for airborne sample analysis of asbestos by TEM; the laboratory will use analysts (names shall be provided) that are currently evaluated as competent with demonstrated proficiency under the NIST NVLAP for airborne sample analysis of asbestos by TEM.] [proficient in conducting analysis for low asbestos concentration, enhanced analysis of floor tiles and bulk materials where multiple layers are present, using an improved EPA test method titled, "Method for the Determination of Asbestos in Bulk Building Materials".]

(4) PCM/TEM: The laboratory is fully equipped and each analyst (name shall be provided) possesses demonstrated proficiency in conducting PCM and TEM analysis of airborne samples using NIOSH Pub No. 84-100Method 7400 PCM and NIOSH Pub No. 84-100 Method 7402 (TEM confirmation of asbestos content of PCM results) from the same filter.

i. Disposal Facility, Transporter: The Contractor shall provide written evidence that the landfill to be used is approved for asbestos disposal by the [USEPA] [and] [state] [and] [local] regulatory agencies. Copies of signed agreements between the Contractor (including subcontractors and transporters) and the asbestos waste disposal facility to accept and dispose of all asbestos containing waste generated during the performance of this contract shall be provided. Qualifications shall be provided for each subcontractor or transporter to be used, indicating previous experience in transport and disposal of asbestos waste to include all required state and local waste hauler requirements for asbestos. The Contractor and transporters shall meet the DOT requirements of 49 CFR 171, 49 CFR 172, and 49 CFR 173 as well as registration requirements of 49 CFR 107 and other applicable state or local requirements. The disposal facility shall meet the requirements of 40 CFR 61, Sections .154 or .155, as required in 40 CFR 61, Section .150(b), and other applicable state or local requirements.

1.5.3 Federal, State or Local Citations on Previous Projects

The Contractor and all subcontractors shall submit a statement, signed by an officer of the company, containing a record of any citations issued by Federal, State or local regulatory agencies relating to asbestos activities (including projects, dates, and resolutions); a list of penalties incurred through non-compliance with asbestos project specifications, including liquidated damages, overruns in scheduled time limitations and resolutions; and situations in which an asbestos-related contract has been terminated (including projects, dates, and reasons for terminations). If there are none, a negative declaration signed by an officer of the company shall be provided.

1.6 REGULATORY REQUIREMENTS

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NOTE: The designer will list the state, regional or local laws, regulations, and statutes, by authority and document number, which apply to the asbestos work to be performed.

Designer should utilize and reference, where appropriate, Section 02120, Transportation and Disposal of Hazardous Materials as a part of the contract documents or include the appropriate Department of Transportation (DOT) requirements from 49 CFR 107, 171, 172, and 173. If Section 02120 is not included, edit this paragraph to include the DOT references. The contract documents must address all applicable DOT requirements including those for shipping, training, certifications, packaging, markings, labelings, and placards for shippers and transporters in addition to USACE, OSHA and EPA requirements.

Include the reference to 40 CFR 763 when asbestos abatement work occurs in an applicable school or where otherwise directed by the customer or required by state and local requirements. The designer will research the state, regional and local laws, regulations, or statutes for applicability.

****

In addition to detailed requirements of this specification, work performed under this contract shall comply with EM 385-1-1, applicable federal, state, and local laws, ordinances, criteria, rules and regulations regarding handling, storing, transporting, and disposing of asbestos waste materials. This includes, but is not limited to, OSHA standards, 29 CFR 1926, especially Section .1101, 40 CFR 61, Subpart M and 40 CFR 763. Matters of interpretation of standards shall be submitted to the appropriate administrative agency for resolution before starting work. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements shall apply. The following state and local laws, rules and regulations regarding demolition, removal, encapsulation, construction alteration, repair, maintenance, renovation, spill/emergency cleanup, housekeeping, handling, storing, transporting and disposing of asbestos material apply: [_____].

1.7 SAFETY AND HEALTH PROGRAM AND PLANS

The Contractor shall develop and submit a written comprehensive site-specific Accident Prevention Plan at least [30] [_____] days prior to the preconstruction conference. The Accident Prevention Plan shall address requirements of EM 385-1-1, Appendix A, covering onsite work to be performed by the Contractor and subcontractors. The Accident Prevention Plan shall incorporate an Asbestos Hazard Abatement Plan, and Activity Hazard Analyses as separate appendices into 1 site specific Accident

Prevention Plan document. Any portions of the Contractor's overall Safety and Health Program that are referenced in the Accident Prevention Plan, e.g., respirator program, hazard communication program, confined space entry program, etc., shall be included as appendices to the Accident Prevention Plan. The plan shall take into consideration all the individual asbestos abatement work tasks identified in Table 1. The plan shall be prepared, signed (and sealed, including certification number if required), and dated by the Contractor's Designated IH, Competent Person, and Project Supervisor.

1.7.1 Asbestos Hazard Abatement Plan Appendix

The Asbestos Hazard Abatement Plan appendix to the Accident Prevention Plan shall include, but not be limited to, the following:

a. The personal protective equipment to be used;

b. The location and description of regulated areas including clean and dirty areas, access tunnels, and decontamination unit (clean room, shower room, equipment room, storage areas such as load-out unit);

c. Initial exposure assessment in accordance with 29 CFR 1926, Section .1101;

d. Level of supervision;

e. Method of notification of other employers at the worksite;

f. Abatement method to include containment and control procedures;

g. Interface of trades involved in the construction;

h. Sequencing of asbestos related work;

i. Storage and disposal procedures and plan;

j. Type of wetting agent and asbestos encapsulant to be used;

k. Location of local exhaust equipment;

l. Air monitoring methods (personal, environmental and clearance);

m. Bulk sampling and analytical methods (if required);

n. A detailed description of the method to be employed in order to control the spread of ACM wastes and airborne fiber concentrations;

o. Fire and medical emergency response procedures;

p. The security procedures to be used for all regulated areas.

1.7.2 Activity Hazard Analyses Appendix

Activity Hazard Analyses, for each major phase of work, shall be submitted and updated during the project. The Activity Hazard Analyses format shall be in accordance with EM 385-1-1 (Figure 1-1). The analysis shall define the activities to be performed for a major phase of work, identify the sequence of work, the specific hazards anticipated, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level. Work shall not proceed on that phase until the Activity Hazard Analyses has been accepted and a preparatory meeting has been conducted by the Contractor to discuss its contents with everyone engaged in the activities, including the onsite Government representatives. The Activity Hazard Analyses shall be continuously reviewed and, when appropriate, modified to address changing site conditions or operations.

1.8 PRECONSTRUCTION CONFERENCE AND ONSITE SAFETY

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NOTE: Specify additional or modified requirements to be addressed in the preconstruction safety conference within the bracket if different from that described. Confer with the District's Construction Office and Safety and Occupational Health Office representatives to make this determination. Refer to EP 415-1-260, Chapter 9, Resident Engineers Management Guide. If this conference is addressed in another specification section, reference the appropriate section.

****

The Contractor and the Contractor's Designated Competent Person, Project Supervisor, and Designated IH shall meet with the Contracting Officer prior to beginning work at a safety preconstruction conference to discuss the details of the Contractor's submitted Accident Prevention Plan to include the Asbestos Hazard Abatement Plan and Activity Hazard Analyses appendices. Deficiencies in the Accident Prevention Plan will be discussed and the Accident Prevention Plan shall be revised to correct the deficiencies and resubmitted for acceptance. Any changes required in the specification as a result of the Accident Prevention Plan shall be identified specifically in the plan to allow for free discussion and acceptance by the Contracting Officer, prior to the start of work. Onsite work shall not begin until the Accident Prevention Plan has been accepted. A copy of the written Accident Prevention Plan shall be maintained onsite. Changes and modifications to the accepted Accident Prevention Plan shall be made with the knowledge and concurrence of the Designated IH, the Project Supervisor, Designated Competent Person, and the Contracting Officer. Should any unforeseen hazard become evident during the performance of the work, the Designated IH shall bring such hazard to the attention of the Project Supervisor, Designated Competent Person, and the Contracting Officer, both verbally and in writing, for resolution as soon as possible. In the interim, all necessary action shall be taken by the Contractor to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public, and the environment. Once accepted by the Contracting Officer, the Accident Prevention Plan, including the Asbestos Hazard Abatement Plan and Activity Hazard Analyses will be enforced as if an addition to the contract. Disregarding the provisions of this contract or the accepted Accident Prevention Plan will be cause for stopping of work, at the discretion of the Contracting Officer, until the matter has been rectified. [_____].

1.9 SECURITY

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NOTE: Specify onsite security requirements to be provided. Confer with the customer and the

District's Construction organization for requirements.

****

[Twenty-four hour security guard] [Fenced and locked security area] [_____] shall be provided for each regulated area. A log book shall be kept documenting entry into and out of the regulated area. Entry into regulated areas shall only be by personnel authorized by the Contractor and the Contracting Officer. Personnel authorized to enter regulated areas shall be trained, be medically evaluated, and wear the required personal protective equipment, for the specific regulated area to be entered.

1.10 MEDICAL REQUIREMENTS

Medical requirements shall conform to 29 CFR 1926, Section .1101.

1.10.1 Medical Examinations

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NOTE: Edit this paragraph in accordance with the most stringent, applicable law.

****

Before being exposed to airborne asbestos fibers, workers shall be provided with a medical examination as required by 29 CFR 1926, Section .1101 and other pertinent state or local requirements. This requirement shall have been satisfied within the last 12 months. The same medical examination shall be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. X-ray films of asbestos workers shall be identified to the consulting radiologist and medical record jackets shall be marked with the word "asbestos."

1.10.1.1 Information Provided to the Physician

The Contractor shall provide the following information in writing to the examining physician:

a. A copy of 29 CFR 1926, Section .1101 and Appendices D, E, G, and I;

b. A description of the affected employee's duties as they relate to the employee's exposure;

c. The employee's representative exposure level or anticipated exposure level;

d. A description of any personal protective and respiratory equipment used or to be used;

e. Information from previous medical examinations of the affected employee that is not otherwise available to the examining physician.

1.10.1.2 Written Medical Opinion

For each worker, a written medical opinion prepared and signed by a licensed physician indicating the following:

a. Summary of the results of the examination.

b. The potential for an existing physiological condition that would place the employee at an increased risk of health impairment from exposure to asbestos.

c. The ability of the individual to wear personal protective equipment, including respirators, while performing strenuous work tasks under cold and/or heat stress conditions.

d. A statement that the employee has been informed of the results of the examination, provided with a copy of the results, informed of the increased risk of lung cancer attributable to the combined effect of smoking and asbestos exposure, and informed of any medical condition that may result from asbestos exposure.

1.10.2 Medical and Exposure Records

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NOTE: Medical records will be retained at least 50 years. Some states require longer retention periods. Check with the state in which the project is located for the required retention time and edit accordingly.

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Complete and accurate records shall be maintained of each employee's medical examinations, medical records, and exposure data, as required by 29 CFR 1910, Section .1910.20 and 29 CFR 1926, Section .1101 for a period of [50] [_____] years after termination of employment. Records of the required medical examinations and exposure data shall be made available, for inspection and copying, to the Assistant Secretary of Labor for Occupational Safety and Health (OSHA) or authorized representatives of the employee and an employee's physician upon request of the employee or former employee. A copy of the required medical certification for each employee shall be maintained on file at the worksite for review, as requested by the Contracting Officer or the representatives.

1.11 TRAINING PROGRAM

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NOTE: The USEPA asbestos training requirements have been delegated to USEPA agreement states. Some states have adopted more stringent training requirements. Edit this paragraph in accordance with the most stringent requirement. Remove subparagraphs that do not apply.

EPA Model Accreditation Plan (MAP) training at 40 CFR 763, Subpart E, Appendix C should be specified for OSHA Class I operations; for OSHA Class II asbestos operations where there will be more than one Class II material to be abated; or where there is only one Class II material to be abated but still required by the state where the work will be conducted.

The designer will specify the OSHA training

requirements for Class II operations (where there is only one Class II material to be abated and the state where the work is to be conducted does not require the EPA MAP training indicated above, or the abatement only involves roofing materials), Class III, or Class IV operations.
****

1.11.1 General Training Requirements

The Contractor shall establish a training program as specified by EPA Model Accreditation Plan (MAP), training requirements at 40 CFR 763, Subpart E, Appendix C, the State of [_____] regulation no. [_____], OSHA requirements at 29 CFR 1926, Section .1101(k)(9), and this specification. Contractor employees shall complete the required training for the type of work they are to perform and such training shall be documented and provided to the Contracting Officer as specified in paragraph QUALIFICATIONS.

1.11.2 Project Specific Training

Prior to commencement of work, each worker shall be instructed by the Contractor's Designated IH and Competent Person in the following project specific training:

a. The hazards and health effects of the specific types of ACM to be abated;

b. The content and requirements of the Contractor's Accident Prevention Plan to include the Asbestos Hazard Abatement Plan and Activity Hazard Analyses and site-specific safety and health precautions;

c. Hazard Communication Program;

d. Hands-on training for each asbestos abatement technique to be employed;

e. Heat and/or cold stress monitoring specific to this project;

f. Air monitoring program and procedures;

g. Medical surveillance to include medical and exposure record-keeping procedures;

h. The association of cigarette smoke and asbestos-related disease;

i. Security procedures;

j. Specific work practice controls and engineering controls required for each Class of work in accordance with 29 CFR 1926, Section .1101.

1.12 RESPIRATORY PROTECTION PROGRAM

The Contractor's Designated IH shall establish in writing, and implement a respiratory protection program in accordance with 29 CFR 1926, Section .1101, 29 CFR 1910, Section .134, ANSI Z88.2, CGA G-7, CGA G-7.1 and DETAIL SHEET 12. The Contractor's Designated IH shall establish minimum respiratory protection requirements based on measured or anticipated levels of airborne asbestos fiber concentrations encountered during the performance of the asbestos abatement work. The Contractor's respiratory protection program shall include, but not be limited to, the following elements:

a. The company policy, used for the assignment of individual responsibility, accountability, and implementation of the respiratory protection program.

b. The standard operating procedures covering the selection and use of respirators. Respiratory selection shall be determined by the hazard to which the worker is exposed.

c. Medical evaluation of each user to verify that the worker may be assigned to an activity where respiratory protection is required.

d. Training in the proper use and limitations of respirators.

e. Respirator fit-testing, i.e., quantitative, qualitative and individual functional fit checks.

f. Regular cleaning and disinfection of respirators.

g. Routine inspection of respirators during cleaning and after each use when designated for emergency use.

h. Storage of respirators in convenient, clean, and sanitary locations.

i. Surveillance of regulated area conditions and degree of employee exposure (e.g., through air monitoring).

j. Regular evaluation of the continued effectiveness of the respiratory protection program.

k. Recognition and procedures for the resolution of special problems as they affect respirator use (e.g., no facial hair that comes between the respirator face piece and face or interferes with valve function; prescription eye wear usage; contact lenses usage; etc.).

l. Proper training in putting on and removing respirators.

1.12.1 Respiratory Fit Testing

A qualitative or quantitative fit test conforming to 29 CFR 1926, Section 1101, Appendix C shall be conducted by the Contractor's Designated IH for each Contractor worker required to wear a respirator, and for the Contracting Officer and authorized visitors who enter a regulated area where respirators are required to be worn. A respirator fit test shall be performed for each worker wearing a negative-pressure respirator prior to initially wearing a respirator on this project and every 6 months thereafter. The qualitative fit tests may be used only for testing the fit of half-mask respirators where they are permitted to be worn, or of full-facepiece air purifying respirators where they are worn at levels at which half-facepiece air purifying respirators are permitted. If physical changes develop that will affect the fit, a new fit test for the worker shall be performed. Functional fit checks shall be performed by employees each time a respirator is put on and in accordance with the manufacturer's recommendation.

1.12.2 Respirator Selection and Use Requirements

The Contractor shall provide respirators, and ensure that they are used as required by 29 CFR 1926, Section .1101 and in accordance with the manufacturer's recommendations. Respirators shall be jointly approved by the Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (MSHA/NIOSH), or by NIOSH, under the provisions of 42 CFR 84, for use in environments containing airborne asbestos fibers. Personnel who handle ACM, enter regulated areas that require the wearing of a respirator, or who are otherwise carrying out abatement activities that require the wearing of a respirator, shall be provided with approved respirators that are fully protective of the worker at the measured or anticipated airborne asbestos concentration level to be encountered. For air-purifying respirators, the particulate filter portion of the cartridges or canister approved for use in airborne asbestos environments shall be high-efficiency particulate air (HEPA). The initial respirator selection and the decisions regarding the upgrading or downgrading of respirator type shall be made by the Contractor's Designated IH based on the measured or anticipated airborne asbestos fiber concentrations to be encountered. Recommendations made by the Contractor's Designated IH to downgrade respirator type shall be submitted in writing to the Contracting Officer. The Contractor's Designated Competent Person in consultation with the Designated IH, shall have the authority to take immediate action to upgrade or downgrade respiratory type when there is an immediate danger to the health and safety of the wearer. Respirators shall be used in the following circumstances:

a. During all Class I asbestos jobs.

b. During all Class II work where the ACM is not removed in a substantially intact state.

c. During all Class II and III work which is not performed using wet methods. Respirators need not be worn during removal of ACM from sloped roofs when a negative exposure assessment has been made and ACM is removed in an intact state.

d. During all Class II and III asbestos jobs where the Contractor does not produce a negative exposure assessment.

e. During all Class III jobs where TSI or surfacing ACM is being disturbed.

f. During all Class IV work performed within regulated areas where employees performing other work are required to wear respirators.

g. During all work where employees are exposed above the PEL-TWA or PEL-Excursion Limit.

h. In emergencies

1.12.3 Class I Work

The Contractor shall provide: (1) a tight-fitting, powered air purifying respirator equipped with high efficiency filters, or (2) a full-facepiece supplied air respirator operated in the pressure demand mode, equipped with HEPA egress cartridges, or (3) an auxiliary positive pressure self-contained breathing apparatus, for all employees within the regulated area where Class I work is being performed; provided that a negative exposure assessment has not been produced, and that the exposure level will not exceed 1 f/cc as an 8-hour time weighted average. A full-facepiece supplied air respirator, operated in the pressure demand mode, equipped with an auxiliary positive pressure self-contained breathing apparatus shall be provided under such conditions, if the exposure assessment indicates exposure levels above 1 f/cc as an 8-hour time weighted average.

1.12.4 Class II and III Work

The Contractor shall provide an air purifying respirator, other than a disposable respirator, equipped with high-efficiency filters whenever the employee performs Class II and III asbestos jobs where the Contractor does not produce a negative exposure assessment; and Class III jobs where TSI or surfacing ACM is being disturbed.

1.12.5 Sanitation

Employees who wear respirators shall be permitted to leave work areas to wash their faces and respirator facepieces whenever necessary to prevent skin irritation associated with respirator use.

1.13 HAZARD COMMUNICATION PROGRAM

A hazard communication program shall be established and implemented in accordance with 29 CFR 1926, Section .59. Material safety data sheets (MSDSs) shall be provided for all hazardous materials brought onto the worksite. One copy shall be provided to the Contracting Officer and 1 copy shall be included in the Contractor's Hazard Communication Program.

1.14 LICENSES, PERMITS AND NOTIFICATIONS

****

NOTE: Determine whether a license or permit is required, who is responsible for submitting required notifications, and which agency has jurisdiction whether the city, county, state, and/or USEPA. Choose the appropriate bracketed items.

****

1.14.1 General Legal Requirements

Necessary licenses, permits and notifications shall be obtained in conjunction with the project's asbestos abatement, transportation and disposal actions and timely notification furnished of such actions as required by federal, state, regional, and local authorities. The [Contractor shall] [Government will] notify the [Regional Office of the USEPA] [state's environmental protection agency responsible for asbestos air emissions] [local air pollution control district/agency] [state OSHA program] [and the Contracting Officer] in writing, at least [10] [_____] days prior to the commencement of work, in accordance with 40 CFR 61, Subpart M, and state and local requirements to include the mandatory "Notification of Demolition and Renovation Record" form and other required notification documents. Notification shall be by Certified Mail, Return Receipt Requested. The Contractor shall furnish copies of the receipts to the Contracting Officer, in writing, prior to the commencement of work. Local fire department shall be notified 3 days before fire-proofing material is removed from a building and the notice shall specify whether or not the material contains asbestos. A copy of the rental company's written acknowledgment and agreement shall be provided as required by paragraph RENTAL EQUIPMENT. For licenses, permits, and notifications that the Contractor is responsible for obtaining, the Contractor shall pay any associated fees or other costs incurred.

1.14.2   Litigation and Notification

The Contractor shall notify the Contracting Officer if any of the following occur:

a. The Contractor or any of the subcontractors are served with notice of violation of any law, regulation, permit or license which relates to this contract;

b. Proceedings are commenced which could lead to revocation of related permits or licenses; permits, licenses or other Government authorizations relating to this contract are revoked;

c. Litigation is commenced which would affect this contract;

d. The Contractor or any of the subcontractors become aware that their equipment or facilities are not in compliance or may fail to comply in the future with applicable laws or regulations.

1.15   PERSONAL PROTECTIVE EQUIPMENT

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NOTE: Modify the number of sets of personal protective equipment as required, depending on the size of the asbestos abatement project.

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[Three] [_____] complete sets of personal protective equipment shall be made available to the Contracting Officer and authorized visitors for entry to the regulated area. Contracting Officer and authorized visitors shall be provided with training equivalent to that provided to Contractor employees in the selection, fitting, and use of the required personal protective equipment and the site safety and health requirements. Contractor workers shall be provided with personal protective clothing and equipment and the Contractor shall ensure that it is worn properly. The Contractor's Designated IH and Designated Competent Person shall select and approve all the required personal protective clothing and equipment to be used.

1.15.1   Respirators

Respirators shall be in accordance with paragraph RESPIRATORY PROTECTION PROGRAM.

1.15.2   Whole Body Protection

****

NOTE: Check state, local and customer requirements and then select the appropriate information.

****

Personnel exposed to airborne concentrations of asbestos that exceed the

PELs, or for all OSHA Classes of work for which a required negative exposure assessment is not produced, shall be provided with whole body protection and such protection shall be worn properly. The Contractor's Designated IH and Competent Person shall select and approve the whole body protection to be used. The Competent Person shall examine work suits worn by employees at least once per work shift for rips or tears that may occur during performance of work. When rips or tears are detected while an employee is working, rips and tears shall be immediately mended, or the work suit shall be immediately replaced. Disposable whole body protection shall be disposed of as asbestos contaminated waste upon exiting from the regulated area. Reusable whole body protection worn shall be either disposed of as asbestos contaminated waste upon exiting from the regulated area or be properly laundered in accordance with 29 CFR 1926, Section .1101. Whole body protection used for asbestos abatement shall not be removed from the worksite by a worker to be cleaned. Recommendations made by the Contractor's Designated IH to downgrade whole body protection shall be submitted in writing to the Contracting Officer. The Contractor's Designated Competent Person, in consultation with the Designated IH, has the authority to take immediate action to upgrade or downgrade whole body protection when there is an immediate danger to the health and safety of the wearer.

1.15.2.1 Coveralls

[Disposable-impermeable] [Disposable-breathable] [Reusable] coveralls with a zipper front shall be provided. Sleeves shall be secured at the wrists, and foot coverings secured at the ankles. See DETAIL SHEET 13.

1.15.2.2 Underwear

Disposable underwear shall be provided. If reusable underwear are used, they shall be disposed of as asbestos contaminated waste or laundered in accordance with 29 CFR 1926, Section .1101. Asbestos abatement workers shall not remove contaminated reusable underwear worn during abatement of ACM from the site to be laundered.

1.15.2.3 Work Clothing

An additional coverall shall be provided when the abatement and control method employed does not provide for the exit from the regulated area directly into an attached decontamination unit. Cloth work clothes for wear under the protective coverall, and foot coverings, shall be provided when work is being conducted in low temperature conditions. Cloth work clothes shall be either disposed of as asbestos contaminated waste or properly laundered in accordance with 29 CFR 1926, Section .1101.

1.15.2.4 Gloves

Gloves shall be provided to protect the hands. Where there is the potential for hand injuries (i.e., scrapes, punctures, cuts, etc.) a suitable glove shall be provided and used.

1.15.2.5 Foot Coverings

Cloth socks shall be provided and worn next to the skin. Footwear, as required by OSHA and EM 385-1-1, that is appropriate for safety and health hazards in the area shall be worn. Rubber boots shall be used in moist or wet areas. Reusable footwear removed from the regulated area shall be thoroughly decontaminated or disposed of as ACM waste. Disposable protective foot covering shall be disposed of as ACM waste. If rubber boots are not used, disposable foot covering shall be provided.

1.15.2.6 Head Covering

Hood type [disposable] [reusable] head covering shall be provided. In addition, protective head gear (hard hats) shall be provided as required. Hard hats shall only be removed from the regulated area after being thoroughly decontaminated.

1.15.2.7 Protective Eye Wear

Eye protection provided shall be in accordance with ANSI Z87.1.

1.16 HYGIENE FACILITIES AND PRACTICES

****

NOTE: Check state, local and customer requirements; consult with in-house engineering, safety and health staff; and select the appropriate information. Remove subparagraphs that do not apply.

A 3-stage decontamination area that includes an equipment, shower and clean room is required for all Class I work involving over 7.5 m (25 feet) or 0.9 square meters (10 square feet) of TSI or surfacing ACM, unless showers are not feasible. A single stage decontamination area or equipment room is required for Class I work involving less than 7.5 m (25 feet) or 0.9 square meters (10 square feet) of TSI or surfacing ACM, and for Class II and Class III asbestos work operations where exposures exceed a PEL-TWA or where there is no negative exposure assessment produced before the operation.

****

The Contractor shall establish a decontamination area for the decontamination of employees, material and equipment. The Contractor shall ensure that employees enter and exit the regulated area through the decontamination area.

1.16.1 Shower Facilities

Shower facilities, when provided, shall comply with 29 CFR 1910, Section .141(d)(3).

1.16.2 3-Stage Decontamination Area

[A temporary negative pressure decontamination unit that is adjacent and attached in a leak-tight manner to the regulated area shall be provided as described in SET-UP DETAIL SHEET Numbers 22 and 23.] [Utilization of prefabricated units shall have prior approval of the Contracting Officer.] The decontamination unit shall have an equipment room and a clean room separated by a shower that complies with 29 CFR 1910, Section .141 (unless the Contractor can demonstrate that such facilities are not feasible). Equipment and surfaces of containers filled with ACM shall be cleaned prior to removing them from the equipment room or area. Surfaces of the equipment room shall be wet wiped 2 times after each shift. Materials used for wet wiping shall be disposed of as asbestos contaminated waste. Two separate lockers shall be provided for each asbestos worker, one in the equipment room and one in the clean room. [Hot water service may be secured from the building hot water system provided backflow protection is installed by the Contractor at the point of connection.] [Should sufficient hot water be unavailable, the Contractor shall provide a minimum 40 gal. electric water heater with minimum recovery rate of 20 gal. per hour and a temperature controller for each showerhead.] The Contractor shall provide a minimum of [2] [_____] showers. Instantaneous type in-line water heater may be incorporated at each shower head in lieu of hot water heater, upon approval by the Contracting Officer. Flow and temperature controls shall be located within the shower and shall be adjustable by the user. The wastewater pump shall be sized for 1.25 times the showerhead flow-rate at a pressure head sufficient to satisfy the filter head loss and discharge line losses. The pump shall supply a minimum 25 gpm flow with 35 ft. of pressure head. Used shower water shall be collected and filtered to remove asbestos contamination. Filters and residue shall be disposed of as asbestos contaminated material, per DETAIL SHEETS 9 and 14. Filtered water shall be discharged to the sanitary system. Wastewater filters shall be installed in series with the first stage pore size of 20 microns and the second stage pore size of 5 microns. The floor of the decontamination unit's clean room shall be kept dry and clean at all times. Water from the shower shall not be allowed to wet the floor in the clean room. Surfaces of the clean room and shower shall be wet-wiped 2 times after each shift change with a disinfectant solution. Proper housekeeping and hygiene requirements shall be maintained. Soap and towels shall be provided for showering, washing and drying. Any cloth towels provided shall be disposed of as ACM waste or shall be laundered in accordance with 29 CFR 1926, Section .1101.

1.16.3 Load-Out Unit

A temporary load-out unit that is adjacent and connected to [the regulated area] [and] [access tunnel] shall be provided as described in DETAIL SHEET Number [20] [and] [25]. Utilization of prefabricated units shall have prior approval of the Contracting Officer. The load-out unit shall be attached in a leak-tight manner to each regulated area. Surfaces of the load-out unit and access tunnel shall be adequately wet-wiped 2 times after each shift change. Materials used for wet wiping shall be disposed of as asbestos contaminated waste.

1.16.4 Single Stage Decontamination Area

A decontamination area (equipment room/area) shall be provided for Class I work involving less than 25 feet or 10 square feet of TSI or surfacing ACM, and for Class II and Class III asbestos work operations where exposures exceed the PELs or where there is no negative exposure assessment produced before the operation. The equipment room or area shall be adjacent to the regulated area for the decontamination of employees, material, and their equipment which is contaminated with asbestos. The equipment room or area shall consist of an area covered by an impermeable drop cloth on the floor or horizontal working surface. The area must be of sufficient size to accommodate cleaning of equipment and removing personal protective equipment without spreading contamination beyond the area. Surfaces of the equipment room shall be wet wiped 2 times after each shift. Materials used for wet wiping shall be disposed of as asbestos contaminated waste.

1.16.5 Decontamination Requirements for Class IV Work

The Contractor shall ensure that employees performing Class IV work within a regulated area comply with the hygiene practice required of employees performing work which has a higher classification within that regulated area, or the Contractor shall provide alternate decontamination area facilities for employees cleaning up debris and material which is TSI or surfacing ACM.

1.16.6 Decontamination Area Entry Procedures

The Contractor shall ensure that employees entering the decontamination area through the clean room or clean area:

a. Remove street clothing in the clean room or clean area and deposit it in lockers.

b. Put on protective clothing and respiratory protection before leaving the clean room or clean area.

c. Pass through the equipment room to enter the regulated area.

1.16.7 Decontamination Area Exit Procedures

The Contractor shall ensure that the following procedures are followed:

a. Before leaving the regulated area, respirators shall be worn while employees remove all gross contamination and debris from their work clothing using a HEPA vacuum.

b. Employees shall remove their protective clothing in the equipment room and deposit the clothing in labeled impermeable bags or containers (see Detail Sheets 9 and 14) for disposal and/or laundering.

c. Employees shall not remove their respirators in the equipment room.

d. Employees shall shower prior to entering the clean room. If a shower has not been located between the equipment room and the clean room or the work is performed outdoors, the Contractor shall ensure that employees engaged in Class I asbestos jobs: a) Remove asbestos contamination from their work suits in the equipment room or decontamination area using a HEPA vacuum before proceeding to a shower that is not adjacent to the work area; or b) Remove their contaminated work suits in the equipment room, without cleaning worksuits, and proceed to a shower that is not adjacent to the work area.

e. After showering, employees shall enter the clean room before changing into street clothes.

1.16.8 Lunch Areas

The Contractor shall provide lunch areas in which the airborne concentrations of asbestos are below 0.01 f/cc.

1.16.9 Smoking

Smoking, if allowed by the Contractor, shall only be permitted in designated areas approved by the Contracting Officer.

1.17 REGULATED AREAS

All Class I, II, and III asbestos work shall be conducted within regulated areas. The regulated area shall be demarcated to minimize the number of persons within the area and to protect persons outside the area from exposure to airborne asbestos. Where critical barriers or negative pressure enclosures are used, they shall demarcate the regulated area. Access to regulated areas shall be limited to authorized persons. The Contractor shall control access to regulated areas, ensure that only authorized personnel enter, and verify that Contractor required medical surveillance, training and respiratory protection program requirements are met prior to allowing entrance.

1.18 WARNING SIGNS AND TAPE

****

NOTE: "Respirators and Protective Clothing Are Required In this Area" will be added to the warning sign when protective equipment is required.

****

Warning signs and tape printed [bilingually] [in English] [and] [_____] [in pictographs and graphics] shall be provided at the regulated boundaries and entrances to regulated areas. The Contractor shall ensure that all personnel working in areas contiguous to regulated areas comprehend the warning signs. Signs shall be located to allow personnel to read the signs and take the necessary protective steps required before entering the area. Warning signs, as shown and described in DETAIL SHEET 11, shall be in vertical format conforming to 29 CFR 1910 and 29 CFR 1926, Section .1101, a minimum of 20 by 14 inches, and displaying the following legend in the lower panel:

DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY

Spacing between lines shall be at least equal to the height of the upper of any two lines. Warning tape shall be provided as shown and described on DETAIL SHEET 11. Decontamination unit signage shall be as shown and described on DETAIL SHEET 15.

1.19 WARNING LABELS

Warning labels shall be affixed to all asbestos disposal containers used to contain asbestos materials, scrap, waste debris, and other products contaminated with asbestos. Containers with preprinted warning labels conforming to requirements are acceptable. Warning labels shall be as described in DETAIL SHEET 14, shall conform to 29 CFR 1926, Section .1101 and shall be of sufficient size to be clearly legible displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD

1.20 LOCAL EXHAUST VENTILATION

****
NOTE: Determine the requirements for local exhaust ventilation.
****

Local exhaust ventilation units shall conform to ANSI Z9.2 and 29 CFR 1926, Section .1101. Filters on local exhaust system equipment shall conform to ANSI Z9.2 and UL 586. Filter shall be UL labeled.

1.21 TOOLS

****
NOTE: Where there is a requirement to collect and transport large volumes of ACM waste using a self-contained trailer or truck mounted asbestos power vacuum system, specify vacuum equipment similar to that described in DETAIL SHEET 26.
****

Vacuums shall be leak proof to the filter, equipped with HEPA filters, of sufficient capacity and necessary capture velocity at the nozzle or nozzle attachment to efficiently collect, transport and retain the ACM waste material. Power tools shall not be used to remove ACM unless the tool is equipped with effective, integral HEPA filtered exhaust ventilation capture and collection system, or has otherwise been approved for use by the Contracting Officer. Residual asbestos shall be removed from reusable tools prior to storage and reuse. Reusable tools shall be thoroughly decontaminated prior to being removed from regulated areas.

1.22 RENTAL EQUIPMENT

If rental equipment is to be used, written notification shall be provided to the rental agency, concerning the intended use of the equipment, the possibility of asbestos contamination of the equipment and the steps that will be taken to decontaminate such equipment. A written acceptance of the terms of the Contractor's notification shall be obtained from the rental agency.

1.23 AIR MONITORING EQUIPMENT

****
NOTE: Delete the EPA Transmission Electron Microscopy (TEM) method if it will not be employed.
****

The Contractor's Designated IH shall approve air monitoring equipment to be used to collect samples. The equipment shall include, but shall not be limited to:

a. High-volume sampling pumps that can be calibrated and operated at a constant airflow up to 16 liters per minute when equipped with a sampling train of tubing and filter cassette.

b. Low-volume, battery powered, body-attachable, portable personal pumps that can be calibrated to a constant airflow up to approximately 3.5 liters per minute when equipped with a sampling train of tubing and filter cassette, and a self-contained rechargeable power pack capable of sustaining the calibrated flow rate for a minimum of 10 hours. The pumps shall also be equipped with an automatic flow control unit which shall maintain a constant flow, even as filter resistance increases due to accumulation of fiber and debris on the filter surface.

c. Single use standard 25 mm diameter cassette, open face, 0.8 micron pore size, mixed cellulose ester membrane filters and cassettes with 50 mm electrically conductive extension cowl, and shrink bands, to be used with low flow pumps in accordance with 29 CFR 1926, Section .1101 for personal air sampling.

d. Single use standard 25 mm diameter cassette, open face, 0.45 micron pore size, mixed cellulose ester membrane filters and cassettes with 50 mm electrically conductive cowl, and shrink bands, to be used with high flow pumps when conducting environmental area sampling using NIOSH Pub No. 84-100 Methods 7400 and 7402, (and the transmission electric microscopy method specified at 40 CFR 763 if required).

e. Appropriate plastic tubing to connect the air sampling pump to the selected filter cassette.

f. A flow calibrator capable of calibration to within plus or minus 2 percent of reading over a temperature range of minus 4 to plus 140 degrees F and traceable to a NIST primary standard.

1.24 EXPENDABLE SUPPLIES

1.24.1 Glovebag

Glovebags shall be provided as described in 29 CFR 1926, Section .1101 and SET-UP DETAIL SHEET 10. The glovebag assembly shall be 6 mil thick plastic, prefabricated and seamless at the bottom with preprinted OSHA warning label.

1.24.2 Duct Tape

Industrial grade duct tape of appropriate widths suitable for bonding sheet plastic and disposal container shall be provided.

1.24.3 Disposal Containers

****

NOTE: Consult customer, federal, state, and local requirements for the type of disposal container allowed.

****

Leak-tight (defined as solids, liquids, or dust that cannot escape or spill out) disposal containers shall be provided for ACM wastes as required by 29 CFR 1926 Section .1101 and DETAIL SHEETS 9A, 9B, 9C and 14.

1.24.4 Disposal Bags

Leak-tight bags, 6 mil thick, shall be provided for placement of asbestos generated waste as described in DETAIL SHEET 9A.

1.24.5 Fiberboard Drums

Fiberboard drums shall be [_____].

1.24.6   Cardboard Boxes

Heavy-duty corrugated cardboard boxes, coated with plastic or wax to retard deterioration from moisture, shall be provided as described in DETAIL SHEET 9C, if required by state and local requirements. Boxes shall fit into selected ACM disposal bags. Filled boxes shall be sealed leak-tight with duct tape.

1.24.7   Sheet Plastic

****

NOTE: Consult customer, federal, state and local requirements. If necessary, specify the type of sheet to be used and select the color and surface treatment.

****

Sheet plastic shall be polyethylene of 6 mil minimum thickness and shall be provided in the largest sheet size necessary to minimize seams, as indicated on the project drawings. Film shall be [clear] [frosted] [or] [black] and conform to ASTM D 4397, except as specified below:

1.24.7.1   Flame Resistant

Where a potential for fire exists, flame-resistant sheets shall be provided. Film shall be [frosted] [or] [black] and shall conform to the requirements of NFPA 701.

1.24.7.2   Reinforced

Reinforced sheets shall be provided where high skin strength is required, such as where it constitutes the only barrier between the regulated area and the outdoor environment. The sheet stock shall consist of translucent, nylon-reinforced or woven-polyethylene thread laminated between 2 layers of polyethylene film. Film shall meet flame resistant standards of NFPA 701.

1.24.8   Amended Water

Amended water shall meet the requirements of ASTM D 1331.

1.24.9   Mastic Removing Solvent

Mastic removing solvent shall be nonflammable and shall not contain methylene chloride, glycol ether, or halogenated hydrocarbons. Solvents used onsite shall have a flash point greater than 140 degrees F.

1.24.10   Leak-tight Wrapping

Two layers of 6 mil minimum thick polyethylene sheet stock shall be used for the containment of removed asbestos-containing components or materials such as reactor vessels, large tanks, boilers, insulated pipe segments and other materials too large to be placed in disposal bags as described in DETAIL SHEET 9B. Upon placement of the ACM component or material, each layer shall be individually leak-tight sealed with duct tape.

1.24.11   Viewing Inspection Window

Where feasible, a minimum of 1 clear, 1/8 inch thick, acrylic sheet, 18 by 24 inches, shall be installed as a viewing inspection window at eye level on a wall in each containment enclosure. The windows shall be sealed leak-tight with industrial grade duct tape.

1.24.12 Wetting Agents

****
NOTE: Review the abatement methods to be employed and edit the paragraph accordingly.
****

Removal encapsulant (a penetrating encapsulant) shall be provided when conducting removal abatement activities that require a longer removal time or are subject to rapid evaporation of amended water. The removal encapsulant shall be capable of wetting the ACM and retarding fiber release during disturbance of the ACM greater than or equal to that provided by amended water. Performance requirements for penetrating encapsulants are specified in paragraph ENCAPSULANTS.

1.24.13 Strippable Coating

****
NOTE: Review abatement methods to be employed and delete if not required.
****

Strippable coating in aerosol cans shall be used to adhere to surfaces and to be removed cleanly by stripping, at the completion of work. This work shall only be done in well ventilated areas.

1.25 MISCELLANEOUS ITEMS

A sufficient quantity of other items, such as, but not limited to: scrapers, brushes, brooms, staple guns, tarpaulins, shovels, rubber squeegees, dust pans, other tools, scaffolding, staging, enclosed chutes, wooden ladders, lumber necessary for the construction of containments, UL approved temporary electrical equipment, material and cords, ground fault circuit interrupters, water hoses of sufficient length, fire extinguishers, first aid kits, portable toilets, logbooks, log forms, markers with indelible ink, spray paint in bright color to mark areas, project boundary fencing, etc., shall be provided.

PART 2 PRODUCTS

2.1 ENCAPSULANTS

Encapsulants shall conform to USEPA requirements, shall contain no toxic or hazardous substances and no solvent and shall meet the following requirements:

ALL ENCAPSULANTS

Requirement	Test Standard
Flame Spread - 25, Smoke Emission - 50	ASTM E 84

ALL ENCAPSULANTS

Requirement	Test Standard
Combustion Toxicity Zero Mortality	Univ. of Pittsburgh Protocol
Life Expectancy, 20 yrs Accelerated Aging Test	ASTM C 732
Permeability, Minimum 0.4 perms	ASTM E 96

Additional Requirements for Bridging Encapsulant

Requirement	Test Standard
Cohesion/Adhesion Test, 50 pounds of force/foot	ASTM E 736
Fire Resistance, Negligible affect on fire resistance rating over 3 hour test (Classified by UL for use over fibrous and cementitious sprayed fireproofing)	ASTM E 119
Impact Resistance, Minimum 43 in-lb (Gardner Impact Test)	ASTM D 2794
Flexibility, no rupture or cracking (Mandrel Bend Test)	ASTM D 522

Additional Requirements for Penetrating Encapsulant

Requirement	Test Standard
Cohesion/Adhesion Test, 50 pounds of force/foot	ASTM E 736
Fire Resistance, Negligible affect on fire resistance rating over 3 hour test(Classified by UL for use over fibrous and cementitious sprayed fireproofing)	ASTM E 119
Impact Resistance, Minimum 43 in-lb (Gardner Impact Test)	ASTM D 2794
Flexibility, no rupture or cracking (Mandrel Bend Test)	ASTM D 522

Additional Requirements for Lockdown Encapsulant

Requirement	Test Standard
Fire Resistance, Negligible affect on fire resistance rating over 3 hour test(Tested with fireproofing over encapsulant applied directly to steel member)	ASTM E 119
Bond Strength, 100 pounds of force/foot (Tests compatibility with cementitious and fibrous fireproofing)	ASTM E 736

2.2 ENCASEMENT PRODUCTS

****
NOTE: This technique is not used often. Before specifying, consult state requirements and ensure that the materials, use requirements and warranties are fully developed with the customer. See RESPONSE ACTION DETAIL SHEETS 66, 67, 69 and 90.
****

Encasement shall consist of primary cellular polymer coat, polymer finish coat, and any other finish coat as approved by the Contracting Officer.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

****
NOTE: Adequately wet removal procedures are required by the EPA NESHAP at 40 CFR 61, Subpart M and OSHA 29 CFR 1926, Section .1101(g)(1)(ii). There are two exceptions to this policy allowing dry removal; they are specified in the EPA 340/1-90-019 NESHAP guidance handbook. In most cases, use wet removal procedures because it is the preferred method and the least hazardous. Dry removal is an option that should be used only where wet removal may damage adjacent areas or equipment, or where safety hazards are identified. If dry removal alone is allowed, carefully edit the specification to remove references to amended water and wetting down procedures and to include a requirement for a written variance submitted by the Contractor, along with the written approval of any regulatory authority having jurisdiction, to the Contracting Officer for review.

Requirements for abatement of asbestos outdoors varies considerably with the work and the location involved. Specify minimum requirements for abatement of asbestos outdoors where construction of a containment is not practical. The designer will provide the best suited, specific requirements necessary for the particular project to prohibit or reduce asbestos exposure to other Contractor employees, customer resources and the general public.
****

Asbestos abatement work tasks shall be performed as shown on the detailed plans and drawings, as summarized in paragraph DESCRIPTION OF WORK and including Table 1 and the Contractor's Accident Prevention Plan, Asbestos Hazard Abatement Plan, and the Activity Hazard Analyses. The Contractor shall use the engineering controls and work practices required in 29 CFR 1926, Section .1101(g) in all operations regardless of the levels of exposure. Personnel shall wear and utilize protective clothing and equipment as specified. The Contractor shall not permit eating, smoking, drinking, chewing or applying cosmetics in the regulated area. All hot work (burning, cutting, welding, etc.) shall be conducted under controlled conditions in conformance with 29 CFR 1926, Section .352, Fire Prevention. Personnel of other trades, not engaged in asbestos abatement activities, shall not be exposed at any time to airborne concentrations of asbestos unless all the administrative and personal protective provisions of the Contractor's Accident Prevention Plan are complied with. Power to the regulated area shall be locked-out and tagged in accordance with 29 CFR 1910, and temporary electrical service with ground fault circuit interrupters shall be provided as needed. Temporary electrical service shall be disconnected when necessary for wet removal. The Contractor shall stop abatement work in the regulated area immediately when the airborne total fiber concentration: (1) equals or exceeds 0.01 f/cc, or the pre-abatement concentration, whichever is greater, outside the regulated area; or (2) equals or exceeds 1.0 f/cc inside the regulated area. The Contractor shall correct the condition to the satisfaction of the Contracting Officer, including visual inspection and air sampling. Work shall resume only upon notification by the Contracting Officer. Corrective actions shall be documented.

3.2 PROTECTION OF ADJACENT WORK OR AREAS TO REMAIN

Asbestos abatement shall be performed without damage to or contamination of adjacent work or area. Where such work or area is damaged or contaminated, as verified by the Contracting Officer using visual inspection or sample analysis, it shall be restored to its original condition or decontaminated by the Contractor at no expense to the Government, as deemed appropriate by the Contracting Officer. This includes inadvertent spill of dirt, dust or debris in which it is reasonable to conclude that asbestos may exist. When these spills occur, work shall stop in all effected areas immediately and the spill shall be cleaned. When satisfactory visual inspection and air sampling analysis results are obtained and have been evaluated by the Contractor's Designated IH and the Contracting Officer, work shall proceed.

3.3 OBJECTS

****

NOTE: When the Government will remove objects, furniture and equipment, there are no Contractor requirements; therefore, select the first bracketed sentence. If the Contractor is to remove or protect objects and furnishings, complete DETAIL SHEET 27, and include appropriate bracketed sentences and paragraphs. Remove subparagraphs that do not apply.

****

3.3.1 Removal of Mobile Objects

[Mobile objects, furniture, [_____] and equipment will be removed from the area of work by the Government before asbestos abatement work begins.] [DETAIL SHEET 27, contains a summary of Contractor's required handling, cleaning and storage and reinstallation of mobile objects, furniture and equipment located in each abatement area. Mobile objects and furnishings identified in DETAIL SHEET 27 [are] [are not] considered contaminated with asbestos fibers. Mobile objects and furnishings shall be precleaned using HEPA filtered vacuum followed by [wet wiping] [and] [or] [steam cleaning]. These objects shall be removed to an area or site designated on DETAIL SHEET 27 and as identified by the Contracting Officer, and stored; or other appropriate action taken as identified on DETAIL SHEET 27. Carpets, draperies, and other items which may not be suitable for onsite wet cleaning methods shall be [properly laundered in accordance with 29 CFR 1926, Section .1101] [disposed of as asbestos contaminated material].]

3.3.2 Stationary Objects

Stationary objects, furniture, [_____], and equipment as shown on DETAIL SHEET 27, shall remain in place [and shall be precleaned using HEPA vacuum followed by adequate wet wiping.] Stationary objects and furnishings shall be covered with 2 layers of polyethylene and edges sealed with duct tape.

3.3.3 Reinstallation of Mobile Objects

At the conclusion of the asbestos abatement work in each regulated area, and after meeting the final clearance requirements for each regulated area, objects previously removed shall be transferred back to the cleaned area from which they came in accordance with the storage code designation for that material as shown on DETAIL SHEET 27, and reinstalled.

3.4 BUILDING VENTILATION SYSTEM AND CRITICAL BARRIERS

****

NOTE: Before specifying, consult with the customer for type of HVAC filters. HVAC filters will be replaced if there is a breach of the critical barriers to the HVAC system; in that case, HVAC filters should be removed, disposed of as asbestos waste, and replaced with like filters at the Contractor's expense.

****

Building ventilating systems supplying air into or returning air out of a regulated area shall be [shut down and isolated by lockable switch or other positive means in accordance with 29 CFR 1910, Section .147.] [isolated by airtight seals to prevent the spread of contamination throughout the system.] Air-tight critical barriers shall be installed on building ventilating openings located inside the regulated area that supply or return air from the building ventilation system or serve to exhaust air from the building. The critical barriers shall consist of [air-tight rigid covers for building ventilation supply and exhaust grills where the ventilation system is required to remain in service during abatement] [2 layers of polyethylene]. Edges to wall, ceiling and floor surfaces shall be sealed with industrial grade duct tape. Critical barriers shall be installed as shown on drawings and appended SET-UP DETAIL SHEETS.

3.5 PRECLEANING

****

NOTE: Before specifying, identify surfaces to be precleaned.

****

[Surfaces shall be [cleaned by HEPA vacuum] [and] [adequately wet wiped] prior to establishment of containment.] [The following surfaces [_____] shall be [_____].]

3.6 METHODS OF COMPLIANCE

****

NOTE: Remove subparagraphs that do not apply.
****

3.6.1 Mandated Practices

****
NOTE: There is an exception to the mandated practices for roofing materials which are conducted in accordance with 29 CFR 1926, Section .1101(g)(8)(ii). See RESPONSE ACTION DETAIL SHEETS 74 or 75 for roofing practices.
****

The Contractor shall employ proper handling procedures in accordance with 29 CFR 1926 and 40 CFR 61, Subpart M, and the specified requirements. The specific abatement techniques and items identified shall be detailed in the Contractor's Asbestos Hazard Abatement Plan including, but not limited to, details of construction materials, equipment, and handling procedures. The Contractor shall use the following engineering controls and work practices in all operations, regardless of the levels of exposure:

a. Vacuum cleaners equipped with HEPA filters to collect debris and dust containing ACM.

b. Wet methods or wetting agents to control employee exposures during asbestos handling, mixing, removal, cutting, application, and cleanup; except where it can be demonstrated that the use of wet methods is unfeasible due to, for example, the creation of electrical hazards, equipment malfunction, and in roofing.

c. Prompt clean-up and disposal in leak-tight containers of wastes and debris contaminated with asbestos.

d. Inspection and repair of polyethylene in work and high traffic areas.

e. Cleaning of equipment and surfaces of containers filled with ACM prior to removing them from the equipment room or area.

3.6.2 Control Methods

The Contractor shall use the following control methods to comply with the PELs:

a. Local exhaust ventilation equipped with HEPA filter dust collection systems;

b. Enclosure or isolation of processes producing asbestos dust;

c. Ventilation of the regulated area to move contaminated air away from the breathing zone of employees and toward a filtration or collection device equipped with a HEPA filter;

d. Use of other work practices and engineering controls;

e. Where the feasible engineering and work practice controls described above are not sufficient to reduce employee exposure to or below the PELs, the Contractor shall use them to reduce employee exposure to the lowest levels attainable by these controls and shall supplement them by the use of respiratory protection that complies with paragraph, RESPIRATORY PROTECTION PROGRAM.

3.6.3 Unacceptable Practices

The following work practices and engineering controls shall not be used for work related to asbestos or for work which disturbs ACM, regardless of measured levels of asbestos exposure or the results of initial exposure assessments:

a. High-speed abrasive disc saws that are not equipped with point of cut ventilator or enclosures with HEPA filtered exhaust air.

b. Compressed air used to remove asbestos, or materials containing asbestos, unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the dust cloud created by the compressed air.

c. Dry sweeping, shoveling, or other dry clean-up of dust and debris containing ACM.

d. Employee rotation as a means of reducing employee exposure to asbestos.

3.6.4 Class I Work Procedures

****

Note: OSHA believes that most outdoor Class I work may be safely done without enclosures (ref. OSHA Instruction CPL 2-2.63, change 1, dated 9 January 1996); that is, OSHA does not require enclosures. An exposure assessment must be made prior to outdoor work to determine other required controls. Remove this paragraph when not required in the project.

****

In addition to requirements of paragraphs Mandated Practices and Control Methods, the following engineering controls and work practices shall be used:

a. A Competent Person shall supervise the installation and operation of the control system.

b. For jobs involving the removal of more than 25 feet or 10 square feet of TSI or surfacing material, the Contractor shall place critical barriers over all openings to the regulated area.

c. HVAC systems shall be isolated in the regulated area by sealing with a double layer of plastic or air-tight rigid covers.

d. Impermeable dropcloths (6 mil or greater thickness) shall be placed on surfaces beneath all removal activity.

e. Objects within the regulated area shall be handled as specified in paragraph OBJECTS.

f. Where a negative exposure assessment has not been provided or where exposure monitoring shows the PEL was exceeded, the regulated area shall be ventilated to move contaminated air away from the employee's breathing zone toward a HEPA unit or collection device.

3.6.5 Specific Control Methods for Class I Work

****

NOTE: Remove these paragraph and/or subparagraphs when not required in the project.

****

In addition to requirements of paragraph Class I Work Procedures, Class I asbestos work shall be performed using the control methods identified in the subparagraphs below.

3.6.5.1 Negative Pressure Enclosure (NPE) System

****

NOTE: Before specifying a negative pressure enclosure system, the designer should determine if an enclosure system is feasible. The enclosure should be the minimum area to encompass all the working surfaces yet allow unencumbered movement by the workers, provide unrestricted air flow past the workers, and ensure walking surfaces can be kept free of tripping hazards.

****

The NPE system shall be as shown in SETUP DETAIL SHEET [2] [3] [4] [8]. The system shall provide at least 4 air changes per hour inside the containment. The local exhaust unit equipment shall be operated 24 hours per day until the containment is removed, and shall be leak-proof to the filter and equipped with HEPA filters. Air movement shall be directed away from the employees and toward a HEPA filtration device. The NPE shall be smoke tested for leaks at the beginning of each shift. Local exhaust equipment shall be sufficient to maintain a minimum pressure differential of minus 0.02 inch of water column relative to adjacent, unsealed areas. Pressure differential shall be monitored continuously, 24 hours per day, with an automatic manometric recording instrument. Pressure differential recordings shall be provided daily on the same day collected. Readings shall be reviewed by the Contractor's Designated Competent Person and IH prior to submittal. The Contracting Officer shall be notified immediately if the pressure differential falls below the prescribed minimum. The building ventilation system shall not be used as the local exhaust system for the regulated area. The local exhaust system shall terminate outdoors unless an alternate arrangement is allowed by the Contract Officer. All filters used shall be new at the beginning of the project and shall be periodically changed as necessary and disposed of as ACM waste.

3.6.5.2 Glovebag Systems

Glovebag systems shall be as shown in SETUP DETAIL SHEET 10. The glovebag system shall be used to remove ACM from straight runs of piping and elbows and other connections. Glovebags shall be used without modification and shall be smoke-tested for leaks and any leaks sealed prior to use. Glovebags shall be installed to completely cover the circumference of pipe or other structures where the work is to be done. Glovebags shall be used only once and shall not be moved. Glovebags shall not be used on surfaces that have temperatures exceeding 150 degrees F. Prior to disposal, glovebags shall be collapsed by removing air within them using a HEPA vacuum. Before beginning the operation, loose and friable material adjacent to the glovebag operation shall be wrapped and sealed in 2 layers of plastic or otherwise rendered intact. At least 2 persons shall perform Class I glovebag removal. Asbestos regulated work areas shall be established as specified and shown on detailed drawings and plans for glovebag abatement. Designated boundary limits for the asbestos work shall be established with rope or other continuous barriers and all other requirements for asbestos control areas shall be maintained, including area signage and boundary warning tape as specified in SET-UP DETAIL SHEET 11.

a. In addition to requirements for negative pressure glovebag systems above, the Contractor shall attach HEPA vacuum systems or other devices to the bag to prevent collapse during removal of ACM from straight runs of piping and elbows and other connections.

b. The negative pressure glove boxes used to remove ACM from pipe runs shall be fitted with gloved apertures and a bagging outlet and constructed with rigid sides from metal or other material which can withstand the weight of the ACM and water used during removal. A negative pressure shall be created in the system using a HEPA filtration system. The box shall be smoke tested for leaks prior to each use.

3.6.5.3 Mini-Enclosures

[Single bulkhead containment] [Double bulkhead containment] [or] [Mini-containment (small walk-in enclosure)] as shown in SETUP DETAIL SHEET [5] [6] [7] to accommodate no more than 2 persons, may be used if the disturbance or removal can be completely contained by the enclosure with the following specifications and work practices. The mini-enclosure shall be inspected for leaks and smoke tested before each use. Air movement shall be directed away from the employee's breathing zone within the mini-enclosure.

3.6.5.4 Wrap and Cut Operation

****

Note: When pipes are insulated with ACM, removal of the entire pipe may be more protective, easier, and more cost-effective than stripping the asbestos insulation from the pipe. The wrap and cut procedure consists of 2 distinct operations. The wrap portion requires the removal of small amounts of asbestos from either side of the pipe to be cut; this will be a Class I or III operation depending on the amount of asbestos removed. Once the asbestos is removed and wrapped, the pipe is then cut. OSHA considers the cutting portion of the job as unclassified, as it does not involve asbestos removal. If the wrap and cut operation is conducted in a negative pressure enclosure system, the glovebag step is not required, although recommended.

****

Wrap and cut operations shall be as shown in SETUP DETAIL SHEET [9B] [10]. Prior to cutting pipe, the asbestos-containing insulation shall be wrapped with polyethylene and securely sealed with duct tape to prevent asbestos becoming airborne as a result of the cutting process. The following steps shall be taken: install glovebag, strip back sections to be cut 6 inches from point of cut, and cut pipe into manageable sections.

3.6.6 Class II Work

****

NOTE: Class II work may also be performed using a method allowed for Class I work, except that glovebags and glove boxes are allowed if they fully enclose the Class II material to be removed. Remove this paragraph when not required in the project.

****

In addition to the requirements of paragraphs Mandated Practices and Control Methods, the following engineering controls and work practices shall be used:

a. A Competent Person shall supervise the work.

b. For indoor work, critical barriers shall be placed over all openings to the regulated area.

c. Impermeable dropcloths shall be placed on surfaces beneath all removal activity.

3.6.7 Specific Control Methods for Class II Work

****

NOTE: If the removal of the adhesive is necessary, wet methods should be used when removing residual adhesive. The adhesive must be either wet-scraped manually or removed using low speed floor machine (300 RPM or less) and wetted sand or a removal solution. The adhesive residues must be placed in an impermeable trash bag while still wet. Remaining water or dirt in the area must then be HEPA vacuumed.

Removal of "intact" cements, coatings, mastics, and flashings is not Class II work. ACM is not rendered non-intact simply by being separated into smaller pieces.

Remove these paragraph and/or subparagraphs when not required in the project.

****

In addition to requirements of paragraph Class II Work, Class II work shall be performed using the following methods:

3.6.7.1 Vinyl and Asphalt Flooring Materials

When removing vinyl and asphalt flooring materials [which contain ACM] [from a building in which ACM has not been verified], the Contractor shall use the following practices as shown in RESPONSE ACTION DETAIL SHEET [56] [57] [58] [59] [60] [61] [62] [63] [64]. Resilient sheeting shall be removed by adequately wet methods. Tiles shall be removed intact (if possible); wetting is not required when tiles are heated and removed intact. Flooring or its backing shall not be sanded. Scraping of residual adhesive and/or backing shall be performed using wet methods. Mechanical chipping is prohibited unless performed in a negative pressure enclosure. Dry sweeping is prohibited. The Contractor shall use vacuums equipped with HEPA filter, disposable dust bag, and metal floor tool (no brush) to clean floors.

3.6.7.2 Roofing Material

****

NOTE: Removal or repair of sections of intact roofing less than 2.3 square meters (25 square feet) in area does not require use of wet methods or HEPA vacuuming as long as manual methods, which do not render the material non-intact, are used to remove the material without creating visible dust. In determining whether a job involves less than 2.3 square meters (25 square feet), the designer should specify all removal and repair work to be performed on the same roof on the same day.

****

When removing roofing materials which contain ACM as described in 29 CFR 1926, Section .1101(g)(8)(ii), the Contractor shall use the following practices as shown in RESPONSE ACTION DETAIL SHEET [74] [75]. Roofing material shall be removed in an intact state. Wet methods shall be used to remove roofing materials that are not intact, or that will be rendered not intact during removal, unless such wet methods are not feasible or will create safety hazards. When removing built-up roofs, with asbestos-containing roofing felts and an aggregate surface, using a power roof cutter, all dust resulting from the cutting operations shall be collected by a HEPA dust collector, or shall be HEPA vacuumed by vacuuming along the cut line. Asbestos-containing roofing material shall not be dropped or thrown to the ground, but shall be lowered to the ground via covered, dust-tight chute, crane, hoist or other method approved by the Contracting Officer. Any ACM that is not intact shall be lowered to the ground as soon as practicable, but not later than the end of the work shift. While the material remains on the roof it shall be kept wet or placed in an impermeable waste bag or wrapped in plastic sheeting. Intact ACM shall be lowered to the ground as soon as practicable, but not later than the end of the work shift. Unwrapped material shall be transferred to a closed receptacle precluding the dispersion of dust. Critical barriers shall be placed over roof level heating and ventilation air intakes.

3.6.7.3 Cementitious Siding and Shingles or Transite Panels

****

NOTE: Alternate work practices which do not involve hand removal may be specified according to 29 CFR 1926, Section .1101(g)(8)(vi), "Alternative Work Practices and Controls"; EPA 340\1-92-013 "A Guide to Normal Demolition Practices Under the Asbestos NESHAP"; EPA document Asbestos/Demolition Decision Tree (1994); state and local requirements; and

Department of Army Memorandum ENVR-EP, subject: "Policy guidance on interpretation of revised EPA asbestos rule affecting demolition and renovation of buildings" dated 22 Jan 1992. For application on multiple building demolition or siding removal, pilot tests to determine feasibility, practicality, and compliance are recommended.
****

When removing cementitious asbestos-containing siding, shingles or transite panels the Contractor shall use the following practices as shown in RESPONSE ACTION DETAIL SHEET [81] [82] [83]. Intentionally cutting, abrading or breaking siding, shingles, or transite panels is prohibited. Each panel or shingle shall be sprayed with amended water prior to removal. Nails shall be cut with flat, sharp instruments. Unwrapped or unbagged panels or shingles shall be immediately lowered to the ground via covered dust-tight chute, crane or hoist, or placed in an impervious waste bag or wrapped in plastic sheeting and lowered to the ground no later than the end of the work shift.

3.6.7.4 Gaskets

Gaskets shall be thoroughly wetted with amended water prior to removal and immediately placed in a disposal container. If a gasket is visibly deteriorated and unlikely to be removed intact, removal shall be undertaken within a glovebag. Any scraping to remove residue shall be performed wet.

3.6.7.5 Other Class II Jobs

The Contractor shall use the following work practices when performing Class II removal of [_____] ACM: The material shall be thoroughly wetted with amended water prior and during its removal. The material shall be removed in an intact state. Cutting, abrading or breaking the material is prohibited. The ACM removed shall be immediately bagged or wrapped.

3.6.8 Specific Control Methods for Class III Work

****
NOTE: Repair and maintenance is considered Class III work if it involves less than 1 glovebag of material, regardless of the time it takes to do the job. If the job involves more than 1 glovebag of TSI or surfacing material then it is a class I job. If the job involves more than 1 bag of other ACM then it is a Class II job.

Taking bulk samples during an asbestos survey is a Class III operation, and, as in all class III operations, a respirator is required when there is no negative exposure assessment.
****

Class III asbestos work shall be conducted using engineering and work practice controls which minimize the exposure to employees performing the asbestos work and to bystander employees. The work shall be performed using wet methods and, to the extent feasible, using local exhaust ventilation. The Contractor shall use impermeable dropcloths and shall isolate the operation, using mini-enclosures or glovebag systems, where the disturbance involves drilling, cutting, abrading, sanding, chipping, breaking, or sawing of TSI or surfacing material.

3.6.9 Specific Control Methods for Class IV Work

Class IV jobs shall be conducted using wet methods, HEPA vacuums, and prompt clean-up of debris containing ACM. Employees cleaning up debris and waste in a regulated area where respirators are required shall wear the selected respirators.

3.6.10 Alternative Methods for Roofing Materials and Asphaltic Wrap

The Contractor shall use the following engineering controls and work practices when removing, repairing, or maintaining intact pipeline asphaltic wrap, or roof cements, mastics, coatings, or flashings which contain asbestos fibers encapsulated or coated by bituminous or resinous compounds. If during the course of the job the material does not remain intact, the Contractor shall use the procedures described in paragraph Roofing Material. Before work begins, and as needed during the job, the Designated Competent Person shall conduct an inspection and determine that the roofing material is intact and will likely remain intact. The material shall not be sanded, abraded, or ground. Manual methods which would render the material non-intact shall not be used. Roofing material shall not be dropped or thrown to the ground but shall be lowered via covered, dust-tight chute, crane, hoist or other method approved by the Contracting Officer. All such material shall be removed from the roof as soon as practicable, but not later than the end of the work shift. Removal or disturbance of pipeline asphaltic wrap shall be performed using wet methods.

3.6.11 Cleaning After Asbestos Removal

****
NOTE: Retain last 2 sentences only when TSI material is present.
****

After completion of all asbestos removal work, surfaces from which ACM has been removed shall be wet wiped or sponged clean, or cleaned by some equivalent method to remove all visible residue. Run-off water shall be collected and filtered through a dual filtration system. A first filter shall be provided to remove fibers 20 micrometers and larger, and a final filter provided that removes fibers 5 micrometers and larger. After the gross amounts of asbestos have been removed from every surface, remaining visible accumulations of asbestos on floors shall be collected using plastic shovels, rubber squeegees, rubber dustpans, and HEPA vacuum cleaners as appropriate to maintain the integrity of the regulated area. When TSI and surfacing material has been removed, workmen shall use HEPA vacuum cleaners to vacuum every surface. Surfaces or locations which could harbor accumulations or residual asbestos dust shall be checked after vacuuming to verify that no asbestos-containing material remains; and shall be re-vacuumed as necessary to remove the ACM.

3.6.12 Class I Asbestos Work Response Action Detail Sheets

****
NOTE: Remove items in this subparagraph that do not apply.
****

The following Class I Asbestos Work Response Action Detail Sheet is specified on Table 1 for each individual work task to be performed:

a. Troweled Wall Plaster on Masonry: See Sheet 32

b. Troweled Wall Plaster on Stud Wall: See Sheet 33

c. Troweled Ceiling Plaster on Structural Substrate: See Sheet 35

d. Troweled Ceiling Plaster on Hung Ceiling: See Sheet 36

e. Acoustical Wall Plaster on Masonry: See Sheet 42

f. Acoustical Ceiling Plaster (Non-Asbestos Substrate): See Sheet 44

g. Asbestos Decorative Paint on Plaster: See Sheet 46

h. Asbestos-contaminated Masonry for Masonry Chimney: See Sheet 50

i. Asbestos-contaminated Masonry Wall or Thermal Insulation: See Sheet 51

j. Fireproofing or Thermal Surface Insulation: See Sheet 68

k. Acoustical Ceiling Insulation: See Sheet 70

l. Exterior Asbestos Stucco: See Sheet 79

m. Duct Insulation: Duct work insulation removal shall not begin without the written authorization of the Contracting Officer stating that the HVAC system to be worked on is either isolated or inoperative and locked out of service. Forced air circulation is not permitted in ductwork while abatement work is in progress. See Sheet 101

n. Pipe Insulation (Using a Glovebag): See Sheet 87

o. Horizontal Pipe Insulation (Using a Containment Area): See Sheet 88

p. Pipe Insulation (Using a Mini-Containment Area): See Sheet 89

q. Storage Tank and Boiler Breeching Insulation: See Sheet 93. Written approval shall be obtained from the Contracting Officer before start of work on tanks and boiler breeching. The Contracting Officer will ensure that tanks and boilers have been valved off or shut down and allowed a sufficient amount of time to cool down. Insulation shall be sprayed with a mist of amended water or removal encapsulant. Amended water or removal encapsulant shall be allowed to saturate material to substrate. Bands or wires holding breeching or insulation to equipment shall be cut. Cover jackets shall be slit at seams, and sections removed and hand-placed in a polyethylene disposable bag. Exposed surfaces shall be continuously sprayed with amended water to minimize airborne dust. Insulation on tanks and boiler breeching shall not be allowed to drop to the floor. Residue shall be removed from tank and boiler surfaces. A water stream shall be used to dislodge insulation in joints or irregular spaces that cannot be reached with tools. Lagging on piping and insulation on fittings shall be removed. A penetrating encapsulant shall be sprayed on all exposed tank, boiler and boiler breeching surfaces.

r. Troweled Wall Plaster on Studs: See Sheet 30

s. Troweled Ceiling or Wall Plaster on Masonry: See Sheet 31

t. Acoustical Ceiling on Wall Plaster: See Sheet 41

u. Interior Stucco: See Sheet 78

v. Exterior Stucco: See Sheet 80

w. Pipe and Fitting Insulation (using Glovebag): See Sheet 86

x. Storage Tank and Boiler Breeching: See Sheet 92

y. Duct Insulation: See Sheet 100.

3.6.13 Class II Asbestos Work Response Action Detail Sheets

****
NOTE: Remove items in this subparagraph that do not apply.
****

The following Class II Asbestos Work Response Action Detail Sheet is specified on Table 1 for each individual work task to be performed:

a. Light Curtain: See Sheet 47

b. Interior Asbestos Cement, Fiberboard and Drywall Panels: See Sheet 48

c. Suspended Asbestos Cement Ceiling Tile: See Sheet 52

d. Asbestos Cement Architectural Products: See Sheet 53

e. Glued-on Acoustical Ceiling and Wall Tile: See Sheet 55

f. Suspended Acoustical Ceiling Tile: See Sheet 54

g. Vinyl or Vinyl Asbestos Tile Adhered to Concrete Floor System by Asbestos-Containing Adhesive: See Sheet 56

h. Vinyl or Vinyl Asbestos Tile Adhered to Wood Floor System by Asbestos Containing Adhesive: See Sheet 60

i. Vinyl Asbestos Tile Adhered to Concrete Floor System by Asbestos Containing Adhesive: See Sheet 57

j. Vinyl Asbestos Tile Adhered to Concrete Floor System by Asbestos Free Adhesive: See Sheet 58

k. Vinyl Asbestos Tile and Chemical Dissolution of Asbestos-Containing Adhesives on Concrete Floor System: See Sheet 59

l. Vinyl Asbestos Tile Adhered to Wood Floor System by Asbestos-Containing Adhesive: See Sheet 61

m. Vinyl Asbestos Tile Adhered to Wood Floor System by Asbestos Free Adhesive: See Sheet 62

n. Sheet Flooring Adhered Wood Floor System: See Sheet 63

o. Asbestos-Containing Sheet Flooring Adhered to Concrete Floor System by Asbestos-Containing Adhesive: See Sheet 64

p. Carpeting (Asbestos-Containing or Contaminated): See Sheet 65

q. Miscellaneous Asbestos-Containing Materials: See Sheet 45

r. Built-Up Roofing and Flashing: See Sheet 74

s. Roof, Shingles and Underlayment: See Sheet 75

t. Asbestos Cement Siding: See Sheet 81

u. Asbestos Cement Roofing: See Sheet 82

v. Asbestos-Containing Walkway Cover: See Sheet 83

w. Asbestos-Contaminated Metal Siding: See Sheet 84

x. Asbestos Cement Sunscreen Louvers: See Sheet 85

y. Electrical Wiring and Fixtures: See Sheet 95

z. Asbestos Insulated Electrical Fixture: See Sheet 96

aa. Boiler Firebox Insulation: The asbestos-containing boiler firebox lining shall be removed from out-of-service boilers before the boiler is dismantled: See Sheet 97.

3.6.14 Abatement of Asbestos Contaminated Soil

****

NOTE: Soil encapsulation will not be an option in traffic areas. Remove this subparagraph if it does not apply. Consult with customer, federal, state, and local agency for requirements for asbestos contaminated soil abatement requirements.

****

[Asbestos contaminated soil shall be removed from areas to a minimum depth of [2] [_____] inches. Soil shall be thoroughly dampened with amended water and then removed by manual shoveling into labeled containers. The workers shall be closely monitored for heat exhaustion. The minimum ventilation shall be 8 air changes per hour through a local exhaust HEPA system. See DETAIL SHEET 73.] [The Contractor has the option to propose encapsulation of soil instead of removal. Since soil encapsulation is highly dependent on soil chemistry, available skills for application and proprietary products, the Contractor shall first test the proposed soil encapsulant on a minimum 100 square feet of soil area onsite. The test shall be witnessed by the Contracting Officer's and the manufacturer's representative. A written application for encapsulation shall be submitted to the Contracting Officer with test results, encapsulant manufacturer's positive recommendation for use, a guarantee for satisfactory performance for 10 years, and limitation of application. The Contracting Officer reserves the right to accept or reject the application with no effect to the contract. If the application is accepted, the soil encapsulation shall proceed in compliance with all provisions and instructions of the encapsulant manufacturer and under the supervision of a person certified by the manufacturer who is trained and experienced in the proper application of the soil encapsulant. See DETAIL SHEET 72.] [A concrete slab of minimum [2] [_____] inch thickness shall be poured over the entire soil surface. Soil surface shall be thoroughly dampened before pouring concrete. Soil encapsulators and supervisors shall be primarily concrete workers trained to work in asbestos contaminated environments. See DETAIL SHEET 71.]

3.6.15 Enclosure of ACM

****

NOTE: Select the applicable requirements for the required enclosure method. Delete encapsulation methods and materials which are not used.

****

Isolation of ACM by construction of a permanent enclosure shall be conducted as specified in Section [_____]. Enclosures shall be as follows:

a. Enclosure of Acoustical Wall Plaster on Masonry Wall: See Detail Sheet 37

b. Enclosure of Asbestos Contaminated Soil: See Detail Sheet 71

c. Enclosure of Acoustical Ceiling Plaster, Spray-on Fireproofing and Thermal Insulation Plaster: See Detail Sheet 43.

3.6.16 Encapsulation of ACM

****

NOTE: Remove items in this subparagraph that do not apply.

****

Prior to applying any encapsulant, the entire surface area shall be inspected for loose, or damaged asbestos material:

a. Penetrating Encapsulation: Before penetrating encapsulation is applied, asbestos removal work in the area shall be complete and the surfaces to be encapsulated shall be free of loose or damaged material. Substrate shall be evaluated before application to ensure that the encapsulant will not cause the substrate to fail in any way. Acoustical wall and ceiling plaster surfaces shall be encapsulated in accordance with manufacturer's recommendations. Plug samples shall be taken to determine if full penetration has been achieved. If full penetration has not been achieved, surfaces shall be recoated while the matrix is still wet, until full penetration is achieved: See Detail Sheet 39.

b. Bridging Encapsulation: Prior to applying the bridging encapsulant, the pre-encapsulation inspection shall be performed. The surface shall be encapsulated in sections of 1000 square feet or less as recommended by the encapsulant manufacturer. Upon completion of each section, the dry thickness of the bridging encapsulation shall be measured. Additional bridging encapsulant shall be applied to obtain the desired encapsulant thickness. Additional coats shall blend with the original bridging encapsulant. Bridging encapsulation shall include:

(1) Troweled Wall Plaster: See Detail Sheet 29
(2) Troweled Ceiling Plaster: See Detail Sheet 34
(3) Acoustical Wall Plaster: See Detail Sheet 38
(4) Acoustical Ceiling Plaster: See Detail Sheet 34
(5) Asbestos Cement Wall, Fiberboard and Drywall Panels: See Detail Sheet 49
(6) Exterior Asbestos Stucco: See Detail Sheet 76
(7) Interior Asbestos Stucco: See Detail Sheet 77
(8) Storage Tank and Boiler Breeching: See Detail Sheet 91
(9) Boiler and Piping Gasket: See Detail Sheet 98.

3.6.17 Combination Encapsulation of Acoustical Wall and Ceiling Plaster

The combination penetrating/bridging encapsulation system shall be installed by first applying the penetrating encapsulant and then the bridging encapsulant: See Detail Sheet 40.

3.6.18 Response Action Detail Sheets for Repair of Class I Materials

****
NOTE: Remove items in this subparagraph that do not apply.
****

a. Troweled Wall Plaster on Studs: See Detail Sheet 30

b. Troweled Ceiling or Wall Plaster on Masonry: See Detail Sheet 31

c. Acoustical Ceiling on Wall Plaster: See Detail Sheet 41

d. Interior Stucco: See Detail Sheet 78

e. Exterior Stucco: See Detail Sheet 80

f. Pipe and Fitting Insulation (using Glovebag): See Detail Sheet 86

g. Storage Tank and Boiler Breeching: See Detail Sheet 92

h. Duct Insulation: See Detail Sheet 100

i. Exposed Pipe Insulation Edges: Asbestos insulation to remain shall have exposed edges contained; the following steps shall be performed: Wet and cut the rough ends true and square with sharp tools and then encapsulate the edges with a 1/4 inch thick layer of non-asbestos-containing insulating cement troweled to a smooth hard finish; when cement is dry, lag the end with a layer of non-asbestos lagging cloth, overlapping the existing ends by 4 inches.

3.6.19 Response Action Detail Sheets for Repair of Class II Materials

a. Vinyl or Vinyl Asbestos Tile Adhered to Concrete Floor System by

Asbestos-Containing Adhesive: See Detail Sheet 56

b. Vinyl or Vinyl Asbestos Tile Adhered to Wood Floor System by Asbestos Containing Adhesive: See Detail Sheet 60.

3.6.20 Encasement of ACM

****
NOTE: Delete items not required for the project.
****

Prior to applying the first layer of the polymer system, the structural stability of the ACM shall be verified. Encasement materials shall not be applied until all removal work within the regulated area has been completed. Mechanical fasteners shall be installed to wall, mesh or deck as needed. A low density cellular or polymer shall be applied to a depth of approximately 1 inch. The asbestos substrate shall be completely encased. A polymer finish containing fiberglass shall be applied over the low density cellular foam to a thickness of 1 inch. All system components shall be applied according to the system manufacturer's instructions and data. Encased material shall be decontaminated. Encasement shall be applied to:

a. Beams and Decking: See Detail Sheet 66

b. Columns: See Detail Sheet 67

c. Acoustical Ceiling Insulation: See Detail Sheet 69

d. Storage Tank and Boiler Breeching: See Detail Sheet 90.

3.6.21 Sealing Contaminated Items Designated for Disposal

****
NOTE: Use this paragraph only when asbestos contaminated items are also designated for removal and disposal.
****

Contaminated architectural, mechanical, and electrical appurtenances such as Venetian blinds, full height partitions, carpeting, duct work, pipes and fittings, radiators, light fixtures, conduit panels, and other contaminated items designated for removal shall be coated with an asbestos lockdown encapsulant at the demolition site before being removed from the asbestos control area. These items [shall] [shall not] be vacuumed prior to application of the lockdown encapsulant. The asbestos lockdown encapsulant shall be tinted a contrasting color and shall be spray applied by airless method. Thoroughness of sealing operation shall be visually gauged by the extent of colored coating on exposed surfaces.

3.7 FINAL CLEANING AND VISUAL INSPECTION

Upon completion of abatement, the regulated area shall be cleaned by collecting, packing, and storing all gross contamination; see SET-UP DETAIL SHEETS 9, 14 and 20. A final cleaning shall be performed using HEPA vacuum and wet cleaning of all exposed surfaces and objects in the regulated area. Upon completion of the cleaning, the Contractor shall conduct a visual pre-inspection of the cleaned area in preparation for a final inspection before final air clearance monitoring and recleaning, as necessary. Upon completion of the final cleaning, the Contractor and the Contracting Officer shall conduct a final visual inspection of the cleaned regulated area in accordance with ASTM E 1368 and document the results on the Final Cleaning and Visual Inspection as specified on the SET-UP DETAIL SHEET 19. If the Contracting Officer rejects the clean regulated area as not meeting final cleaning requirements, the Contractor shall reclean as necessary and have a follow-on inspection conducted with the Contracting Officer. Recleaning and follow-up reinspection shall be at the Contractor's expense.

3.8 LOCKDOWN

Prior to removal of plastic barriers and after clean-up of gross contamination and final visual inspection, a post removal (lockdown) encapsulant shall be spray applied to ceiling, walls, floors, and other surfaces in the regulated area.

3.9 EXPOSURE ASSESSMENT AND AIR MONITORING

****

NOTE: Air sampling regimen depends on the abatement techniques specified and applicable laws. Consult the state, local and customer requirements and edit accordingly.

****

3.9.1 General Requirements For Exposure

Exposure assessment, air monitoring and analysis of airborne concentration of asbestos fibers shall be performed in accordance with 29 CFR 1926, Section .1101, the Contractor's air monitoring plan, and as specified. Personal exposure air monitoring (collected at the breathing zone) that is representative of the exposure of each employee who is assigned to work within a regulated area shall be performed by the Contractor's Designated IH. Breathing zone samples shall be taken for at least 25 percent of the workers in each shift, or a minimum of 2, whichever is greater. Air monitoring results at the 95 percent confidence level shall be calculated as shown in Table 2 at the end of this section. [[The Contractor shall] [The Contracting Officer will] provide an onsite independent testing laboratory with qualified analysts and appropriate equipment to conduct sample analyses of air samples using the methods prescribed in 29 CFR 1926, Section .1101, to include NIOSH Pub No. 84-100 Method 7400.] Preabatement and abatement environmental air monitoring shall be performed by the [Contractor's Designated IH] [and] [Contracting Officer's IH]. Final clearance environmental air monitoring, shall be performed by the [Contractor's Designated IH] [Contracting Officer's IH]. Environmental and final clearance air monitoring shall be performed using [NIOSH Pub No. 84-100 Method 7400 (PCM) with optional confirmation of results by NIOSH Pub No. 84-100 Method 7402 (TEM)] [the EPA TEM Method specified in 40 CFR 763]. For environmental and final clearance, air monitoring shall be conducted at a sufficient velocity and duration to establish the limit of detection of the method used at 0.005 f/cc. Confirmation of asbestos fiber concentrations (asbestos f/cc) from environmental and final clearance samples collected and analyzed by NIOSH Pub No. 84-100 Method 7400 (total f/cc) may be conducted using TEM in accordance with NIOSH Pub No. 84-100 Method 7402. When such confirmation is conducted, it shall be from the same sample filter used for the NIOSH Pub No. 84-100 Method 7400 PCM analysis. For all Contractor required environmental or final clearance air monitoring, confirmation of asbestos fiber concentrations, using NIOSH Pub

No. 84-100 Method 7402, shall be at the Contractor's expense. Monitoring may be duplicated by the Government at the discretion of the Contracting Officer. Results of breathing zone samples shall be posted at the job site and made available to the Contracting Officer. The Contractor shall maintain a fiber concentration inside a regulated area less than or equal to 0.1 f/cc expressed as an 8 hour, time-weighted average (TWA) during the conduct of the asbestos abatement. If fiber concentration rises above 0.1 f/cc, work procedures shall be investigated with the Contracting Officer to determine the cause. At the discretion of the Contracting Officer, fiber concentration may exceed 0.1 f/cc but shall not exceed 1.0 f/cc expressed as an 8-hour TWA. The Contractor's workers shall not be exposed to an airborne fiber concentration in excess of 1.0 f/cc, as averaged over a sampling period of 30 minutes. Should either an environmental concentration of 1.0 f/cc expressed as an 8-hour TWA or a personal excursion concentration of 1.0 f/cc expressed as a 30-minute sample occur inside a regulated work area, the Contractor shall stop work immediately, notify the Contracting Officer, and implement additional engineering controls and work practice controls to reduce airborne fiber levels below prescribed limits in the work area. Work shall not restart until authorized by the Contracting Officer.

3.9.2 Initial Exposure Assessment

****
NOTE: Delete last sentence if not applicable.
****

The Contractor's Designated IH shall conduct an exposure assessment immediately before or at the initiation of an asbestos abatement operation to ascertain expected exposures during that operation. The assessment shall be completed in time to comply with the requirements which are triggered by exposure data or the lack of a negative exposure assessment, and to provide information necessary to assure that all control systems planned are appropriate for that operation. The assessment shall take into consideration both the monitoring results and all observations, information or calculations which indicate employee exposure to asbestos, including any previous monitoring conducted in the workplace, or of the operations of the Contractor which indicate the levels of airborne asbestos likely to be encountered on the job. [For Class I asbestos work, until the employer conducts exposure monitoring and documents that employees on that job will not be exposed in excess of PELs, or otherwise makes a negative exposure assessment, the Contractor shall presume that employees are exposed in excess of the PEL-TWA and PEL-Excursion Limit.]

3.9.3 Negative Exposure Assessment

The Contractor shall provide a negative exposure assessment for the specific asbestos job which will be performed. The negative exposure assessment shall be provided within [_____] days of the initiation of the project and conform to the following criteria:

a. Objective Data: Objective data demonstrating that the product or material containing asbestos minerals or the activity involving such product or material cannot release airborne fibers in concentrations exceeding the PEL-TWA and PEL-Excursion Limit under those work conditions having the greatest potential for releasing asbestos.

b. Prior Asbestos Jobs: Where the Contractor has monitored prior asbestos jobs for the PEL and the PEL-Excursion Limit within 12 months of the current job, the monitoring and analysis were performed in compliance with asbestos standard in effect; the data were obtained during work operations conducted under workplace conditions closely resembling the processes, type of material, control methods, work practices, and environmental conditions used and prevailing in the Contractor's current operations; the operations were conducted by employees whose training and experience are no more extensive than that of employees performing the current job; and these data show that under the conditions prevailing and which will prevail in the current workplace, there is a high degree of certainty that the monitoring covered exposure from employee exposures will not exceed the PEL-TWA and PEL-Excursion Limit.

c. Initial Exposure Monitoring: The results of initial exposure monitoring of the current job, made from breathing zone air samples that are representative of the 8-hour PEL-TWA and 30-minute short-term exposures of each employee. The monitoring covered exposure from operations which are most likely during the performance of the entire asbestos job to result in exposures over the PELs.

3.9.4 Preabatement Environmental Air Monitoring

****

NOTE: The designer shall research the state, regional and local laws, regulations, statutes, etc., to determine air monitoring requirements. Demolition projects may not require clearance monitoring.

****

Preabatement environmental air monitoring shall be established [1 day] [_____] prior to the masking and sealing operations for each regulated area to determine background concentrations before abatement work begins. As a minimum, preabatement air samples shall be collected using NIOSH Pub No. 84-100 Method 7400, PCM at these locations: outside the building; inside the building, but outside the regulated area perimeter; and inside each regulated work area. One sample shall be collected for every 2000 square feet of floor space. At least 2 samples shall be collected outside the building: at the exhaust of the HEPA unit; and downwind from the abatement site. The PCM samples shall be analyzed within 24 hours; and if any result in fiber concentration greater than 0.01 f/cc, asbestos fiber concentration shall be confirmed using NIOSH Pub No. 84-100 Method 7402 (TEM).

3.9.5 Environmental Air Monitoring During Abatement

Until an exposure assessment is provided to the Contracting Officer, environmental air monitoring shall be conducted at locations and frequencies that will accurately characterize any evolving airborne asbestos fiber concentrations. The assessment shall demonstrate that the product or material containing asbestos minerals, or the abatement involving such product or material, cannot release airborne asbestos fibers in concentrations exceeding 0.01 f/cc as a TWA under those work conditions having the greatest potential for releasing asbestos. The monitoring shall be at least once per shift at locations including, but not limited to, close to the work inside a regulated area; preabatement sampling locations; outside entrances to a regulated area; close to glovebag operations;

representative locations outside of the perimeter of a regulated area; inside clean room; and at the exhaust discharge point of local exhaust system ducted to the outside of a containment (if used). If the sampling outside regulated area shows airborne fiber levels have exceeded background or 0.01 f/cc, whichever is greater, work shall be stopped immediately, and the Contracting Officer notified. The condition causing the increase shall be corrected. Work shall not restart until authorized by the Contracting Officer.

3.9.6 Final Clearance Air Monitoring

****

NOTE: The designer will research the state, regional and local laws, regulations, statutes, etc., and consult with the customers to determine final air clearance monitoring requirements. (Demolition projects may not require clearance sampling). Remove and/or edit the subparagraphs accordingly.

****

Prior to conducting final clearance air monitoring, the Contractor and the Contracting Officer shall conduct a final visual inspection of the regulated area where asbestos abatement has been completed. The final visual inspection shall be as specified in SET-UP DETAIL SHEET 19. Final clearance air monitoring shall not begin until acceptance of the Contractor's final cleaning by the Contracting Officer. [The Contractor's Designated IH shall] [The Contracting Officer's IH will] conduct final clearance air monitoring using aggressive air sampling techniques as defined in EPA 560/5-85-024 or as otherwise required by federal or state requirements. The sampling and analytical method used will be [NIOSH Pub No. 84-100Method 7400 (PCM) and Table 3 with confirmation of results by NIOSH Pub No. 84-100 Method 7402 (TEM).] [the EPA TEM Method specified at 40 CFR 763 and Table 4.]

3.9.6.1 Final Clearance Requirements, NIOSH PCM Method

For PCM sampling and analysis using NIOSH Pub No. 84-100 Method 7400, the fiber concentration inside the abated regulated area, for each airborne sample, shall be less than 0.01 f/cc. The abatement inside the regulated area is considered complete when every PCM final clearance sample is below the clearance limit. If any sample result is greater than 0.01 total f/cc, the asbestos fiber concentration (asbestos f/cc) shall be confirmed from that same filter using NIOSH Pub No. 84-100 Method 7402 (TEM) at Contractor's expense. If any confirmation sample result is greater than 0.01 asbestos f/cc, abatement is incomplete and cleaning shall be repeated. Upon completion of any required recleaning, resampling with results to meet the above clearance criteria shall be done.

3.9.6.2 Final Clearance Requirements, EPA TEM Method

For EPA TEM sampling and analysis, using the EPA Method specified in 40 CFR 763, abatement inside the regulated area is considered complete when the arithmetic mean asbestos concentration of the 5 inside samples is less than or equal to 70 structures per square millimeter (70 S/mm). When the arithmetic mean is greater than 70 S/mm, the 3 blank samples shall be analyzed. If the 3 blank samples are greater than 70 S/mm, resampling shall be done. If less than 70 S/mm, the 5 outside samples shall be analyzed and a Z-test analysis performed. When the Z-test results are less than 1.65, the decontamination shall be considered complete. If the Z-test results are more than 1.65, the abatement is incomplete and cleaning shall be repeated. Upon completion of any required recleaning, resampling with results to meet the above clearance criteria shall be done.

3.9.6.3 Air Clearance Failure

If clearance sampling results fail to meet the final clearance requirements, the Contractor shall pay all costs associated with the required recleaning, resampling, and analysis, until final clearance requirements are met.

3.9.7 Air-Monitoring Results and Documentation

****

NOTE: Consult with customer on turn around time for sample results in the blank. This is sometimes dependent upon the location of the abatement project and the availability of testing laboratories to turn sample results quickly. Some state or local regulators, Corps of Engineer districts or customers may require the Contracting Officer retain an air sampling firm to provide air monitoring quality assurance.

****

Air sample fiber counting shall be completed and results provided within 24 hours (breathing zone samples), and [_____] hours (environmental/clearance monitoring) after completion of a sampling period. The Contracting Officer shall be notified immediately of any airborne levels of asbestos fibers in excess of established requirements. Written sampling results shall be provided within 5 working days of the date of collection. The written results shall be signed by testing laboratory analyst, testing laboratory principal and the [Contractor's Designated IH] [Contracting Officer's IH]. The air sampling results shall be documented on a Contractor's daily air monitoring log. The daily air monitoring log shall contain the following information for each sample:

a. Sampling and analytical method used;

b. Date sample collected;

c. Sample number;

d. Sample type: BZ = Breathing Zone (Personal), P = Preabatement, E = Environmental, C = Abatement Clearance;

e. Location/activity/name where sample collected;

f. Sampling pump manufacturer, model and serial number, beginning flow rate, end flow rate, average flow rate (L/min);

g. Calibration date, time, method, location, name of calibrator, signature;

h. Sample period (start time, stop time, elapsed time (minutes);

i. Total air volume sampled (liters);

j. Sample results (f/cc and S/mm square) if EPA methods are required for final clearance;

k. Laboratory name, location, analytical method, analyst, confidence level. In addition, the printed name and a signature and date block for the Industrial Hygienist who conducted the sampling and for the Industrial Hygienist who reviewed the daily air monitoring log verifying the accuracy of the information.

3.10 CLEARANCE CERTIFICATION

When asbestos abatement is complete, ACM waste is removed from the regulated areas, and final clean-up is completed, the Contracting Officer will certify the areas as safe before allowing the warning signs and boundary warning tape to be removed. After final clean-up and acceptable airborne concentrations are attained, but before the HEPA unit is turned off and the containment removed, the [Contractor shall] [Government will] remove all pre-filters on the building HVAC system and provide new pre-filters. The Contractor shall dispose of such filters as asbestos contaminated materials. HVAC, mechanical, and electrical systems shall be re-established in proper working order. The Contractor and the Contracting Officer shall visually inspect all surfaces within the containment for residual material or accumulated debris. The Contractor shall reclean all areas showing dust or residual materials. The Contracting Officer will certify in writing that the area is safe before unrestricted entry is permitted. The Government will have the option to perform monitoring to certify the areas are safe before entry is permitted.

3.11 CLEANUP AND DISPOSAL

3.11.1 Title to ACM Materials

ACM material resulting from abatement work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of as specified and in accordance with applicable federal, state and local regulations.

3.11.2 Collection and Disposal of Asbestos

****

NOTE: Consult 40 CFR 61, Subpart M, customer, state, regional and local requirements.

****

All ACM waste including contaminated wastewater filters, scrap, debris, bags, containers, equipment, and asbestos contaminated clothing, shall be collected and placed in leak-tight containers such as double plastic bags (see DETAIL SHEET 9A); sealed double wrapped polyethylene sheet (see DETAIL 9B); sealed fiberboard boxes (see DETAIL SHEET 9C); or other approved containers. Waste within the containers shall be wetted in case the container is breeched. Asbestos-containing waste shall be disposed of [at an EPA, state and local approved asbestos landfill] [off Government property]. For temporary storage, sealed impermeable containers shall be stored in an asbestos waste load-out unit or in a storage/transportation conveyance (i.e., dumpster, roll-off waste boxes, etc.) in a manner acceptable to and in an area assigned by the Contracting Officer. Procedure for hauling and disposal shall comply with 40 CFR 61, Subpart M, state, regional, and local standards.

3.11.3 Scale Weight Measurement

****
NOTE: Remove this subparagraph when not required or edit accordingly.
****

Scales used for measurement shall be public scales. Weighing shall be at a point nearest the work at which a public scale is available. Scales shall be standard truck scales of the beam type; scales shall be equipped with the type registering beam and an "over and under" indicator; and shall be capable of accommodating the entire vehicle. Scales shall be tested, approved and sealed by an inspector of the State of [_____]. Scales shall be calibrated and resealed as often as necessary and at least once every three months to ensure continuous accuracy. Vehicles used for hauling ACM shall be weighed empty daily at such time as directed and each vehicle shall bear a plainly legible identification mark.

3.11.4 Weigh Bill and Delivery Tickets

****
NOTE: Remove this subparagraph when not required or edit accordingly.
****

Copies of weigh bills and delivery tickets shall be submitted to the Contracting Officer during the progress of the work. The Contractor shall furnish the Contracting Officer scale tickets for each load of ACM weighed and certified. These tickets shall include tare weight; identification mark for each vehicle weighed; and date, time and location of loading and unloading. Tickets shall be furnished at the point and time individual trucks arrive at the worksite. A master log of all vehicle loading shall be furnished for each day of loading operations. Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified weigh bills and/or certified tickets and manifests of all ACM actually disposed by the Contractor for this contract.

3.11.5 Asbestos Waste Shipment Record

The Contractor shall complete and provide the Contracting Officer final completed copies of the Waste Shipment Record for all shipments of waste material as specified in 40 CFR 61, Subpart M and other required state waste manifest shipment records, within 3 days of delivery to the landfill. Each Waste Shipment Record shall be signed and dated by the [Contractor] [Contracting Officer], the waste transporter and disposal facility operator.

TABLE 1

INDIVIDUAL WORK TASK DATA ELEMENTS

Sheet_____ of _____

There is a separate data sheet for each individual work task.

1. WORK TASK DESIGNATION NUMBER ________
2. LOCATION OF WORK TASK____
   ____
3. BRIEF DESCRIPTION OF MATERIAL TO BE ABATED:____________________
   ____

   a. Type of Asbestos ______________________________
   b. Percent asbestos content ____________________%

4. ABATEMENT TECHNIQUE TO BE USED_________________________________
5. OSHA ASBESTOS CLASS DESIGNATION FOR WORK TASK__________________
6. EPA NESHAP FRIABILITY DESIGNATION FOR WORK TASK
   Friable _____ Non-friable Category I _____
   Non-friable Category II_____
7. FORM _____ and CONDITION OF ACM: GOOD_____ FAIR_____ POOR_____
8. QUANTITY: METERS__________________, SQUARE METERS_____________
8a. QUANTITY: LINEAR FT.______________, SQUARE FT._______________
9. RESPONSE ACTION DETAIL SHEET NUMBER FOR WORK TASK______________
10. SET-UP DETAIL SHEET NUMBERS
    FOR WORK TASK __________, __________, __________, __________,
    __________, __________, __________, __________.

NOTES:

(1) Numeric sequence of individual work tasks (1,2,3,4, etc.) for each regulated area. Each category of EPA friability/OSHA class has a separate task.

(2) Specific location of work (building, floor, area, e.g., Building 1421, 2nd Floor, Rm 201)

(3) A description of material to be abated (example: horizontal pipe, cement wall panels, tile, stucco, etc.) type of asbestos (chrysotile, amosite, crocidolite, etc.); and % asbestos content.

(4) Technique to be used: Removal = REM; Encapsulation = ENCAP; Encasement = ENCAS; Enclosure = ENCL; Repair = REP.

(5) Class designation: Class I, II, III, or IV (OSHA designation).

(6) Friability of materials: Check the applicable EPA NESHAP friability designation.

(7) Form: Interior or Exterior Architectural = IA or EA; Mechanical/Electrical = ME.
Condition: Good = G; Fair = F; Poor = P.

(8) Quantity of ACM for each work task in meters or square meters.

(8a) Quantity of ACM for each work task in linear feet or square feet.

(9) Response Action Detail Sheet specifies the material to be abated and the methods to be used. There is only one Response Action Detail Sheet for each abatement task.

(10) Set-up Detail Sheets indicate containment and control methods used in support of the response action (referenced in the selected Response Action Detail Sheet).

TABLE 2

FORMULA FOR CALCULATION OF THE 95 PERCENT CONFIDENCE LEVEL
(Reference: NIOSH 7400)

Fibers/cc(01.95 percent CL) = X + [(X) * (1.645) * (CV)]

Where: X = ((E)(AC))/((V)(1000))

E = ((F/Nf) - (B/Nb))/Af

CV = The precision value; 0.45 shall be used unless the analytical laboratory provides the Contracting Officer with documentation (Round Robin Program participation and results) that the laboratory's precision is better.

AC = Effective collection area of the filter in square millimeters

V = Air volume sampled in liters

E = Fiber density on the filter in fibers per square millimeter

F/Nf = Total fiber count per graticule field

B/Nb = Mean field blank count per graticule field

Af = Graticule field area in square millimeters

TWA = C1/T1 + C2/T2 = Cn/Tn

Where: C = Concentration of contaminant

T = Time sampled.

TABLE 3

NI0SH METHOD 7400

PCM ENVIRONMENTAL AIR SAMPLING PROTOCOL (NON-PERSONAL)

Sample Location	Minimum No. of Samples	Filter Pore Size (Note 1)	Min. Vol. (Note 2) (Liters)	Sampling Rate (liters/min.)
Inside Abatement Area	0.5/140 Square Meters (Notes 3 & 4)	0.45 microns	1500	2-10
Each Room in 1 Abatement Area Less than 140 Square meters		0.45 microns	1500	2-10
Field Blank	2	0.45 microns	0	0
Laboratory Blank	1	0.45 microns	0	0

Notes:

1. Type of filter is Mixed Cellulose Ester.

2. Ensure detection limit for PCM analysis is established at 0.005 fibers/cc.

3. One sample shall be added for each additional 140 square meters. (The corresponding I-P units are 5/1500 square feet).

4. A minimum of 5 samples are to be taken per abatement area, plus 2 field blanks.

TABLE 4

EPA AHERA METHOD: TEM AIR SAMPLING PROTOCOL

Location Sampled	Minimum No. of Samples	Filter Pore Size	Min. Vol. (Liters)	Sampling Rate (liters/min.)
Inside Abatement Area	5	0.45 microns	1199	2-10
Outside Abatement Area	5	0.45 microns	1199	2-10
Field Blank	2	0.45 microns	0	0
Laboratory Blank	1	0.45 microns	0	0

Notes:

1. Type of filter is Mixed Cellulose Ester.

2. The detection limit for TEM analysis is 70 structures/square mm.

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

PROJECT NAME ___________________________ CONTRACT NO. ________________________
PROJECT ADDRESS ____
CONTRACTOR FIRM NAME ____
EMPLOYEE'S NAME ___________________________,________________,_______,
(Print) (Last) (First) (MI)

Social Security Number: _______-_______-________,

WORKING WITH ASBESTOS CAN BE DANGEROUS. INHALING ASBESTOS FIBERS HAS BEEN LINKED WITH TYPES OF LUNG DISEASE AND CANCER. IF YOU SMOKE AND INHALE ASBESTOS FIBERS, THE CHANCE THAT YOU WILL DEVELOP LUNG CANCER IS GREATER THAN THAT OF THE NONSMOKING PUBLIC.

Your employer's contract for the above project requires that you be provided and you complete formal asbestos training specific to the type of work you will perform and project specific training; that you be supplied with proper personal protective equipment including a respirator, that you be trained in its use; and that you receive a medical examination to evaluate your physical capacity to perform your assigned work tasks, under the environmental conditions expected, while wearing the required personal protective equipment. These things are to be done at no cost to you. By signing this certification, you are acknowledging that your employer has met these obligations to you. The Contractor's Designated Industrial Hygienist will check the block(s) for the type of formal training you have completed. Review the checked blocks prior to signing this certification.

FORMAL TRAINING:
_____ a. For Competent Persons and Supervisors: I have completed EPA's Model Accreditation Program (MAP) training course, "Contractor/Supervisor", that meets this State's requirements.

b. For Workers:
_____ (1) For OSHA Class I work: I have completed EPA's MAP training course, "Worker", that meets this State's requirements.
_____ (2) For OSHA Class II work (where there will be abatement of more than one type of Class II materials, i.e., roofing, siding, floor tile, etc.): I have completed EPA's MAP training course, "Worker", that meets this State's requirements.
(3) For OSHA Class II work (there will only be abatement of one type of Class II material):
_____ (a) I have completed an 8-hour training class on the elements of 29 CFR 1926, Section .1101(k)(9)(viii), in addition to the specific work practices and engineering controls of 29 CFR 1926, Section .1101(g) and hands-on training.
_____ (b) I have completed EPA's MAP training course, "Worker", that meets this State's requirements.
_____ (4) For OSHA Class III work: I have completed at least a 16-hour course consistent with EPA requirements for training of local education agency maintenance and custodial staff at 40 CFR 763, Section .92(a)(2) and the elements of 29 CFR 1926, Section .1101(k)(9)(viii), in addition to the specific work practices and engineering controls at 29 CFR 1926, Section .1101, and hands-on training.

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

_____ (5) For OSHA Class IV work: I have completed at least a 2-hr course consistent with EPA requirements for training of local education agency maintenance and custodial staff at 40 CFR 763, (a)(1), and the elements of 29 CFR 1926, Section .1101(k)(9)(viii), in addition to the specific work practices and engineering controls at 29 CFR 1926, Section .1101(g) and hands-on training.

_____ c. Workers, Supervisors and the Designated Competent Person: I have completed annual refresher training as required by EPA's MAP that meets this State's requirements.

PROJECT SPECIFIC TRAINING:
_____ I have been provided and have completed the project specific training required by this Contract. My employer's Designated Industrial Hygienist and Designated Competent Person conducted the training.

RESPIRATORY PROTECTION:
_____ I have been trained in accordance with the criteria in the Contractor's Respiratory Protection program. I have been trained in the dangers of handling and breathing asbestos dust and in the proper work procedures and use and limitations of the respirator(s) I will wear. I have been trained in and will abide by the facial hair and contact lens use policy of my employer.

RESPIRATOR FIT-TEST TRAINING:
_____ I have been trained in the proper selection, fit, use, care, cleaning,maintenance, and storage of the respirator(s) that I will wear. I have been fit-tested in accordance with the criteria in the Contractor's Respiratory Program and have received a satisfactory fit. I have been assigned my individual respirator. I have been taught how to properly perform positive and negative pressure fit-check upon donning negative pressure respirators each time.

MEDICAL EXAMINATION:
_____ I have had a medical examination within the last twelve months which was paid for by my employer. The examination included: health history, pulmonary function tests, and may have included an evaluation of a chest x-ray. A physician made a determination regarding my physical capacity to perform work tasks on the project while wearing personal protective equipment including a respirator. I was personally provided a copy and informed of the results of that examination. My employer's Industrial Hygienist evaluated the medical certification provided by the physician and checked the appropriate blank below. The physician determined that there:

_____ were no limitations to performing the required work tasks.
_____ were identified physical limitations to performing the required work tasks.

Date of the medical examination __________________

Employee Signature ______________________________________ date ___________
Contractor's Industrial
Hygienist Signature _____________________________________ date ___________

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-13852 (November 1997)**
U.S. ARMY CORPS OF ENGINEERS | **-------------------------**
Superseding
CEGS-16722 (June 1991)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

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11/97

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DEPARTMENT OF THE ARMY **CEGS-13852 (November 1997)**
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GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 13852

FIRE ALARM REPORTING SYSTEM, RADIO TYPE
11/97

****
NOTE: This guide specification covers the requirements for radio transmitted fire alarm reporting systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided in the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 15	Radio Frequency Devices

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA ANSI/EIA/TIA-222-F	(1991) Structural Standards for Steel Antenna Towers and Antenna Supporting Structures

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991) Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(1993) Industrial Control and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996; Errata) National Electrical Code
NFPA 72	(1996; Errata) National Fire Alarm Code
NFPA 780	(1997) Installation of Lightning Protection Systems

UNDERWRITERS LABORATORIES (UL)

UL 6	(1997) Rigid Metal Conduit
UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 797	(1993; Rev thru Mar 1997) Electrical Metallic Tubing
UL 1242	(1996) Intermediate Metal Conduit

1.2 GENERAL REQUIREMENTS

1.2.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that can provide service within 24 hours.

1.2.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

1.2.3 Tags

Tags with stamped identification numbers shall be furnished for keys and locks.

1.2.4 Keys and Locks

Locks shall be keyed alike.

1.2.5 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.2.6 Compliance

****

NOTE: Insert appropriate NFPA Standard in blank.

****

The central reporting system shall comply with [NFPA 72] [_____]. The equipment furnished shall be listed by Underwriters Laboratories, or Factory Mutual Engineering and Research, or be approved or listed by a nationally recognized testing laboratory.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item to the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Battery; [_____].

Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component, each panel component and the battery recharging period shall be included.

Spare Parts; [_____].

Spare parts data for each different item of material and equipment specified, after approval of detail drawings, and not later than [_____] months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after [1] [_____] year of service.

Qualifications; [_____].

Qualifications, with verification of experience and license number, of a Registered Professional Engineer with at least 4 years of current experience in the design of fire protection and detection systems. This engineer must perform the various specification items required by this section to be performed by a Registered Professional Engineer.

SD-04 Drawings

Fire Alarm Reporting System; [_____].

Detail drawings, signed by the Registered Professional Engineer, consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical detectors. The contractor shall check the layout based on the actual detectors to be installed and make any necessary revisions in the detail drawings. Detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

Wiring Diagrams; [_____].

Detail point-to-point wiring diagram, signed by the Registered Professional Engineer, showing all points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, an all equipment that is activated or controlled by the panel.

SD-06 Instructions

Fire Alarm Reporting System; GA.

[Six] [_____] complete copies of operating instructions outlining step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. [Six] [_____] copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The instructions shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. Instructions shall be approved prior to training.

Training; [_____].

Training course for the operation and maintenance staff. The course shall be conducted in the building where the system is installed or as designated by the Contracting Officer. The training period shall consist of [3] [_____] training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The instructions shall cover all of the items contained in the operating and maintenance instructions.

SD-08 Statements

Test Procedures; [_____].

Detailed test procedures for the fire alarm reporting system [60] [_____] days prior to performing system tests. The test procedures shall be signed by the Registered Professional Engineer.

SD-09 Reports

Testing; [_____].

Test reports in booklet form showing all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document all readings, test results and indicate the final position of controls.

SD-13 Certificates

Equipment; [_____].

Certified copies of current applicable approvals or listings issued by UL, FM or other nationally recognized testing laboratory showing compliance with applicable NFPA standards.

1.4   DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be protected from the weather, humidity and temperature variations, dirt, dust, and other contaminants.

1.5   SYSTEM OPERATION

****

NOTE: Radio link supervision may be by periodic reporting of radio fire alarm transmitters or by periodic polling of all transmitters by the radio fire alarm receiver. The total number of transmitters on any one frequency and their polling rate in a two-way system must be determined and checked to ensure code compliance. The following definitions are given to help clarify the use of the words transmitter and receiver in this specification.

1. "Fire Alarm Transmitter" refers to any device that transmits a fire alarm message back to the fire alarm receiver at the alarm monitoring station.

2. "Radio Transmitter" is an electronic device that generates a coded RF signal.

3. "Radio Fire Alarm Transmitter" refers to a device that uses radio signals to transmit a fire alarm message back to the alarm monitoring station. The radio fire alarm transmitter may operate with either one-way or two-way data transmission. For one-way data transmission, the radio fire alarm transmitter would incorporate a radio transmitter,

antenna, cables, power supply, message encoder, and possibly an interface circuit.

The radio fire alarm transmitter generates and sends a coded alarm when an alarm is received at the transmitter. The signal is received at the radio fire alarm receiver and an alarm is given.

Radio fire alarm transmitters that use two-way data transmissions have all the same components as the one-way system, but, in addition, they have a receiver and controller. They operate by waiting for the radio fire alarm receiver to send them a radio signal to report. The radio fire alarm transmitter then sends back a signal reporting any alarms. Another method involves two-way radio transmission systems which transmit signals as soon as they are received.

4. "Fire Alarm Receivers" refer to equipment that receives fire alarm messages from one or more fire alarm transmitters.

5. "Radio Receiver" is an electronic device that detects radio signals and generates an alarm message.

6. "Radio Fire Alarm Receiver" is a system that receives fire alarm signals, displays, and records the alarm messages. It may simply listen for any alarm messages (one-way data transmission) or it may sequentially transmit a radio signal asking each radio fire alarm transmitter to report any alarms (two-way data transmission).

When an addition to an existing system is required, provide the make, model number, and other pertinent information to the designer. This will eliminate most of this specification because the additional interfaces have to be compatible with the existing central radio fire alarm reporting system.
****

The radio system shall report alarms to the radio fire alarm monitoring base station. The system shall be a completely supervised radio type fire alarm reporting system. The system shall indicate the area of alarm. The radio communication link shall be supervised and operated in accordance with NFPA 72.

1.6 ELECTRICAL SUPERVISION

Electrical supervision shall be provided for all circuits and for all positions of interface panel control switches.

PART 2 PRODUCTS

2.1 RADIO FIRE ALARM TRANSMITTER (TRANSCEIVER)

****
NOTE: Transceiver is a radio device that receives an interrogating or challenging radio signal and automatically transmits a response on the same or a different frequency.
****

Radio Fire Alarm Transmitter (Transceiver) shall be compatible with the Radio Fire Alarm Monitoring Base Station. The transmitter shall be all solid state and comply with applicable portions of 47 CFR 15 governing type acceptance. All transmitters of a common configuration shall be interchangeable with the other devices furnished by the manufacturer. Each transmitter [and interface device] shall be the manufacturer's current commercial product completely assembled, wired, tested at the factory, and delivered ready for installation and operation.

2.1.1 Frequency Allocation

****
NOTE: Frequency assignment is made by the base's communications Officer. The frequency must be reserved in advance. Multiple frequencies may be needed to meet response time requirements. Polling type systems will need separate polling frequencies.
****

The transmitters shall operate on a frequency of [_____] MHz.

2.1.2 Power Requirements

****
NOTE: Delete requirements for manual street boxes if not applicable.
****

Transmitters shall be powered by a combination of locally available 120 Vac, and sealed [nickel-cadium] [or] [lead-acid] type batteries requiring no additional water. [Transmitters used in manual street box configuration [as indicated] shall be powered by battery only.] In the event of loss of 120 Vac power, the transmitter shall automatically switch to battery operation. The switchover shall be accomplished with no interruption of protective service, without adversely affecting the battery-powered capabilities, and shall cause the transmission of a trouble message in no less than [_____] seconds. Upon restoration of ac power, transfer back to normal ac power supply shall be automatic and the battery shall be recharged. The converter/battery charger shall be installed within the transmitter housing. Power supply transient filtering shall be provided.

2.1.2.1 Battery Power

The battery package shall be capable of supplying all the power requirements for a given transmitter.

2.1.2.2 Battery Duration

Radio fire alarm transmitter standby battery capacity shall provide sufficient power to operate the transmitter in a normal standby status for a minimum of 60 hours and shall be capable of transmitting alarms during that period. The capacity for battery-only powered transmitters shall be 6 months before recharging is necessary.

2.1.2.3 Battery Supervision

Each radio fire alarm transmitter shall constantly monitor and supervise its own battery powered supply. A low-battery condition shall be reported when battery voltage falls below 85 percent of the rated voltage.

2.1.3 Functional Requirements

2.1.3.1 Interfacing Indicators and Controls

Transmitters shall incorporate the provisions for auxiliary interconnection to existing interior alarm systems.

2.1.3.2 Generation of Signals

Each transmitter shall be a standard design which allows the immediate transmission of all initiated signals.

2.1.3.3 Power Output

****

NOTE: The designer should provide the necessary data to determined the required RF power level; this may require a site visit.

****

The radio frequency (RF) power output of each transmitter shall be sufficient for reliable alarm reporting. The minimum RF power output shall be [1] [_____] watt.

2.1.3.4 Memory

Transmitters shall have memory capability. Multiple, simultaneous alarms shall not result in the loss of any messages. Messages shall be stored until they are transmitted.

2.1.3.5 Transmission Confirmation

****

NOTE: Use with fire alarm boxes only.

****

When a signal is initiated at a public box (push button or pull lever), the transmitter shall produce an audible or visual indication that the transmitter is operating and that a signal is being sent.

2.1.3.6 Transmitter Identity Code

Each transmitter shall transmit a distinct identity code number as part of all signals emanating from the transmitter. The identity code shall allow for no less than a [_____] digit code selection and be transmitted not less than three complete rounds (cycles).

2.1.3.7 Message Designations

Each transmitter shall allow as a minimum no less than 10 [_____] distinct and individually identifiable message designations as to the types or causes of transmitter actuation.

a. Master Message: Master messages shall be transmitted upon automatic actuation of the transmitter. The building and zone causing actuation shall be individually identified as part of this transmission. The transmitter shall be capable of identifying and transmitting a minimum of [_____] master (zone) messages.

b. Test Message: Test message shall be capable of both manual and automatic actuation. When a transceiver method is employed, it shall provide for automatic interrogation at preselected periods or continuous automatic interrogation in accordance with the governing standard. Additionally, transceiver systems shall provide for selective interrogation at times determined by the user. Testing the automatic test actuation shall occur a minimum of once in each [24-] [_____] hour period, at an optionally preselected time. Stability of the electronic actuating device shall be plus or minus 1 minute per month within the temperature range stipulated for system operation. Actuation of the "Test" message designation, regardless of initiating means, shall cause no less than 1 complete message to be sent.

c. Tamper Message Designation: The tamper message shall be automatically transmitted when a tamper switch is tripped in the transmitter housing.

d. Trouble Message Designation: Trouble message shall be automatically transmitted in the event of a failure in excess of 1 minute of the main operating power source of the transmitter.

2.1.4 Transmitter Housings

The housings on transmitters shall be fabricated from corrosion-resistant cast metal or suitable substitute which has the physical strength sufficient to ward off physical damage normally expected to be received by vandalism. The housing shall be sealed against the entry of moisture, dust, dirt, insects, and other foreign objects. Exterior housings shall be NEMA 4X.

2.1.4.1 Lock

Internal components shall be protected from vandalism by a tamper-proof lock on the transmitter housing. The housing shall allow access to all internal components for testing, servicing, and replacement at the installation site.

2.1.4.2 Mounting

****

NOTE: Choose the type of mounting most suited for application of design.

****

Transmitter housings shall be designed for universal mounting on walls, poles, or pedestals. Mounting shall utilize either lag bolts, anchor bolts, stainless steel banding, mounting brackets, or a shackle/bolt combination, as applicable to the specific installation.

2.1.4.3 Operating Panel

****
NOTE: Use with manual street boxes only.
****

Each publicly accessible transmitter shall have an operating panel that incorporates a dedicated signal initiating device (pull hook or push button) clearly identified for the initiation of "FIRE" signals. The device shall be protected with a conventional spring-loaded, "fast-action" break-glass, or similar pull-type door that allows observation of the actuation device when in the closed position. The door shall be fabricated and finished in a manner consistent with that required of the main housing.

2.1.4.4 Labeling

****
NOTE: Use with manual street boxes only.
****

Each publicly accessible transmitter shall be labeled on both sides and on the front surface with the word "FIRE." The label shall be white with red lettering.

2.1.5 Environmental Operating Requirements

****
NOTE: Check local condition for design wind gust and ice loading. Lowest design wind speed is 160.9 km per hour (100 mph); typical design wind speed is 201.2 km per hour (125 mph).
****

The transmitter shall be designed for reliable outside operation in an ambient temperature range of [-22] [_____] to [140] [_____] degrees F. Transmitters shall be corrosion-resistant and designed for reliable operation under adverse climatic conditions including [100] [_____] mph winds, ice, rain, and snow storms.

2.1.6 Painting

Radio fire alarm transmitter [and interface housings] shall be factory painted. The finish color shall be [fire engine red] [_____]. Painted surfaces damaged during installation shall be repainted to match existing paint.

2.2 RADIO TRANSMITTER INTERFACE DEVICE

****
NOTE: If a radio transmitter interface device is not required, delete this paragraph.
****

The interface device shall provide a means of converting the signals that are available from the local control equipment into a form that is compatible with the transmitter inputs, while still maintaining electrical supervision of the entire system. Interface devices shall be utilized when direct connection between local control equipment and the transmitter is not possible. Interface devices shall be completely assembled, wired, tested at the factory, and delivered ready for installation and operation.

2.2.1 Enclosure

****
NOTE: Use with manual street boxes only.
****

When furnished as an independent self-contained device, the interface device shall be incorporated into an enclosure conforming to NEMA ICS 1or other national standard as required by its location.

2.2.2 Indicators

****
NOTE: Use with manual street boxes only.
****

Indicators shall be provided to indicate alarm and trouble conditions and shall consist of a red fire alarm and an amber trouble light. The indicators shall be designed to ensure visibility during daylight hours and to indicate the reporting zone.

2.2.3 Access

Switches and other controls shall not be accessible without the use of a key. Access to controls shall be by unlocking and opening a panel or door.

2.2.4 Mounting

****
NOTE: Choose the type of mounting most suited for application of design.
****

Interface housings shall be designed for universal mounting on walls, poles, or pedestals. Mounting shall utilize either lag bolts, anchor bolts, stainless steel banding, mounting brackets, or a shackle/bolt combination, as applicable to the specific installation.

2.2.5 Inputs/Outputs

Each interface panel shall provide, as a minimum, the number of alarm circuit inputs and outputs indicated. Each input circuit shall be arranged so that the alarm signals shall override the trouble signals.

2.3 RADIO FIRE ALARM MONITORING BASE STATION

****
NOTE: Radio link supervision may be by periodic reporting of radio fire alarm transmitters or by periodic polling of all transmitters by the radio fire alarm receiver. The total number of transmitters on any one frequency and the polling rate of the transmitters in a two-way system must be

determined and checked to ensure code compliance.
****

2.3.1 Receiver (Transceiver) System

[Two identical] [One] master radio fire alarm receiving (transceiver) system compatible with transmitter frequency shall be provided. The system shall be completely assembled, wired, tested at the factory, and delivered ready for installation and operation. Transceivers shall be solid-state design and shall use frequency modulation. The transceiver can be a single integrated unit, or it may consist of separate transmitter and receiver modules with a common power supply, amplifier, and control unit.

2.3.1.1 Transmitter Section

Transmitter shall operate on a frequency of [_____] MHz. Frequency stability shall be within 0.00025 percent over the operating temperature range. Transmitter shall be designed to work into a 50-ohm load. Frequency deviation shall be less than or equal to 5 kHz. Audio response shall be within plus 1 dB and minus 3 dB over the 300 Hz to 3,000 Hz range.

2.3.1.2 Receiver Section

Receiver antenna input impedance shall be 50 ohms. Receiver shall be tuned to a frequency assignment of [_____] mHz. Receiver shall have no more than 5 percent audio distortion measured at 1,000 Hz. Receiver shall have a noise level not greater than minus 50 dB below the signal level. Receiver output shall be compatible with the associated device.

2.3.2 Fire Alarm Console

Console shall contain a complete and independent fire alarm receiving system, consisting of, as a minimum, a radio receiver/transmitter, signal to message decoder, audio alarm signaling devices, audio alarm silence switch, visual display, alarm reset switch(es), alarm recording printer, primary and emergency power supplies, power supply monitors, memory devices, and all necessary interconnecting cables.

2.3.2.1 Audible Fire Alarm

The audible alarm signaling devices used to indicate the receipt of fire alarm messages shall produce a unique sound. The device shall be internally mounted in the console and shall be activated upon receipt of all fire alarm signals. The audible devices used to indicate the receipt of transmitter/interface trouble messages, including tamper and low-battery voltage, shall be separate and distinct from the device used to denote receipt of fire alarm messages.

2.3.2.2 Visual Display

****
NOTE: Listed displays are minimum requirements, but if additional visual displays are required, such displays must be added to the list.
****

Console display shall indicate, as a minimum, the originating transmitter identity code number and shall include the following message designations:

a. Fire

b. Trouble

c. Battery

d. Test

e. Tamper

f. Master Zone [_____] thru [_____]

2.3.2.3 Console Memory

Console shall have a memory buffer capable of retaining a minimum of [500] [_____] transmitter codes, together with the specific message designations associated with each transmitter. The system shall reject any received message not matching the programmed transmitter codes where such message identification code is not stored in the system. Upon command, the console shall display and print a summary of transmitters which have transmitted a low-battery or trouble message, or failed to transmit a message during the previous 24 [_____]-hour test period. Any incoming transmitter signal shall pre-empt the command display and printout function, and be processed, displayed, and printed. The 24-hour memory shall not be purged and shall always be current and available. Transmitter memory data shall not be lost in the event of a total loss of operating or emergency power supplies.

2.3.2.4 Console Supervision

The supervisory system shall provide constant supervision of the operating conditions of the console. Indicators shall be provided for each major component, and an audible signal shall be produced in the event of failure of any major component. A switch shall be provided to silence the audible trouble signal.

2.3.2.5 Receiver Supervision

The supervisory system shall provide constant supervision and display of the operating condition of the radio receivers, and shall indicate an abnormal condition when a radio fire alarm transmitter carrier lasting more than 15 seconds is detected. The receiver's ability to properly receive and decode an incoming signal shall be tested at least once every [_____] minutes.

2.3.2.6 Manual Battery Test

Console shall have a switch to manually place the console on emergency battery power for test purposes.

2.3.2.7 Electrical Connections

Console shall be designed with modular components to allow interchange of components for maintenance purposes. Primary power cables shall incorporate positive twist-lock connections. Interconnecting cables and connectors shall be compatible with computer quality signal data transmission.

2.3.3 Antenna System

****

NOTE: The antenna for the dual transmitter and receivers shall be installed with a maximum vertical separation. The designer must check local conditions for design wind gust and ice loading. The lowest design wind speed is 160.9 km per hour (100 mph); typical design wind speed is 201.2 km per hour (125 MPR).

****

The antenna system shall utilize vertical polarization antennas, communication links between transmitters/receivers and antennas, and matching networks as needed for the proper coverage. The antenna system shall be either omni-directional or shaped-coveraged as selected by the Contractor based on the topography. The antenna system and cabling shall be furnished to provide adequate system gain. The antennas shall be capable of withstanding the environmental conditions of [125][_____] mph wind and 1/2 inch radial] [_____] ice without failure. Lightning protection shall comply with NFPA 780. Antenna supporting structures shall comply with EIA ANSI/EIA/TIA-222-F.

2.3.3.1 Grounding Conductors

Antenna grounding conductors shall be minimum 32-strand, No. 17 AWG copper.

2.3.3.2 Communication Links

Transmission line between the transmitter/receiver and the antenna shall be 50-ohm impedance rated for the transmitter output power. As a minimum, cable shall exhibit an attenuation not exceeding 1.1 dB per 100 feet at 200 mHz.

2.4 FIRE ALARM SYSTEM PERIPHERAL EQUIPMENT

****

NOTE: Check the terrain and distances to determine if a repeater will be needed to transmit a signal from a remote location to the main control console.

****

2.4.1 Repeaters

Repeaters shall be provided where indicated or required to meet system requirements. The repeater shall receive on [_____] MHz and transmit on [_____] mHz. The receiver and transmitter sections shall conform to the requirements specified for transceivers. Two-way data transmission shall be relayed between the base station and remote stations. Repeater shall utilize a bandpass-type duplexer and one antenna, or multiple-bandpass cavity filters and multiple antennas. The duplexer or filter cavities shall isolate the receiver from transmitter spurious noise and prevent receiver desensitization. The duplexer or filter cavities shall be rated to handle the output power of the transmitter. Repeater shall be keyed with tone-encoded control circuit. A transmitter time-out circuit shall be provided to prevent system lockup.

2.4.2 Radio Fire Alarm Transmitter Box Location Light

****

NOTE: Use with fire alarm boxes only. Delete paragraph where a light is not required. Do not use for radio fire alarm transmitters that operate on batteries only.

****

Each indicated transmitter providing publicly accessible actuating functions shall be provided with a vapor-tight, incandescent type light fixture constructed of a flame retardant, nonplastic, polycarbonate material with a threaded ruby globe. The light shall be supported with 1/2 inch galvanized steel conduit and located approximately 1 foot above the box. The light shall be provided with an incandescent, 50-watt, 120-volt extended service lamp. Transmitters which are powered by battery only shall not be equipped with location lights.

2.4.3 Conduit

Conduit and fittings shall comply with UL 6, UL 1242, and UL 797.

2.4.4 Ground Rods

****

NOTE: Designer will determine the size, type, and number of ground rods to be used based on local conditions, earth resistivity data, and on the size and type of the electrical installation. Copper-clad steel rods will be specified for normal conditions. Zinc-coated steel or stainless steel rods will be used where low soil resistivities are encountered and galvanic corrosion may occur between adjacent underground metallic masses and the copper-clad rods. Stainless steel rods have a longer life than the zinc-coated steel, but use of zinc-coated steel must be justified based on the higher cost. Rods 16 mm (5/8 inch) in diameter and 2.5 m (8 feet) in length are generally acceptable; however, in rocky soils 19 mm (3/4 inch) rods shall be specified. In high resistivity soils, 3 m (10 foot) or sectional rods may be used to obtain the required resistance to ground. Where rock is encountered, additional rods, a counterpoise, or ground grid may be necessary. Coordinate and standardize rod selection for individual facilities with other specification sections.

****

Ground rods shall be of [copper-clad steel conforming to UL 467] [zinc-coated steel conforming to ANSI C135.30] [solid stainless steel not less than [5/8][3/4] inch in diameter by [8][10] feet in length] [of the sectional type].

2.4.5 Power Supply

****

NOTE: Locations with automatic backup power generation shall require as a minimum 4 hours backup.

****

The operating power for the system shall be single phase taken from the building electric service as specified in paragraph Power Supply for the System. Emergency backup power shall be provided by sealed [lead-acid] [or] [nickel-calcium] type batteries requiring no additional water. The charging system shall recharge fully discharged batteries within 12 hours and maintain the batteries in the fully charged state. The battery shall have the capacity to operate the system for not less than 48 hours under maximum normal load with the power supply to the charger disconnected.

2.4.6 Wiring

Wiring shall be in accordance with NFPA 70 and as indicated. Station wiring shall be color coded.

2.4.7 Special Tools and Spare Parts

Special tools necessary for the maintenance of the equipment shall be furnished. One spare set of fuses of each type and size required and 5 spare lamps of each type shall be furnished.

PART 3 EXECUTION

3.1 INSTALLATION

All work shall be installed as shown and in accordance with the manufacturer's recommendations, unless otherwise specified. Necessary interconnections, services, and adjustments required for a complete and operational system shall be provided. Electrical work shall be in accordance with NFPA 70.

3.1.1 Power Supply for the System

A single dedicated branch-circuit connection for supplying power to the fire alarm system shall be provided. The backup power supply shall be automatically energized upon failure of the normal power supply.

3.1.2 Wiring

Wiring for systems shall be installed in rigid conduit, intermediate metallic conduit, or electric metallic tubing. The conductors for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. The sum of the cross-sectional areas of individual conductors shall not exceed 40 percent of the interior cross-sectional area of the conduit. Conduit shall comply with NFPA 70. Ample gutter space to accommodate necessary wiring shall be provided.

3.2 OVERVOLTAGE AND SURGE PROTECTION

Equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 and NFPA 70. Cables and conductors which serve as communications links, except fiber optics, shall have surge protection circuits installed at each end. Fuses shall not be used for surge protection.

3.3 GROUNDING

Ground rods shall not protrude more than 6 inches above grade. Noncurrent-carrying metallic parts associated with radio fire alarm equipment shall have a maximum resistance to solid "earth" ground not to exceed 25 ohms.

3.4 TESTING

The Contractor shall notify the Contracting Officer 30 days before the performance and acceptance tests are to be conducted. The tests shall be performed in the presence of the Contracting Officer under the supervision of the fire alarm system manufacturer's qualified representative. The Contractor shall furnish all instruments and personnel required for the tests.

3.4.1 Performance Testing

Upon completion of the installation, the system shall be subjected to a complete functional and operational performance test by the Contractor. Test shall determine that the system is free from grounded, shorted, or open circuits. When all corrections have been made, the system shall be retested to assure that it is functional. Copies of performance test reports shall be submitted in accordance with paragraph SUBMITTALS.

3.4.2 Acceptance Test

****

NOTE: Listed tests are minimum required. If additional tests are required such tests must be added to the list.

****

The testing shall be in accordance with NFPA 72. The recommended tests in NFPA 72 shall be considered mandatory and shall verify that all previous deficiencies have been corrected. The tests shall include the following:

a. Tests to indicate there are no grounded, shorted, or open circuits.

b. Tests of each radio fire alarm transmitter/receiver/transceiver/ repeater.

c. Tests of radio fire alarm monitoring base station for all required functions.

d. Tests of normal and emergency power supplies.

3.4.3 Training

The Contractor shall conduct a training course for operating staff in the building where the system is installed as designated by the Contracting Officer. The training period shall consist of [1 training day] [[_____] training days], [8] [_____] hours per day and shall start after the system is functionally completed but prior to the final acceptance tests. The field instructions shall cover all of the items contained in the approved operating and maintenance instructions.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-13920 (March 1998)**

U.S. ARMY CORPS OF ENGINEERS **-----------------------**

CEGS-15320 (May 1992)

GUIDE SPECIFICATION FOR CONSTRUCTION

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 13920

FIRE PUMPS
03/98

****
Note: This guide specification covers the requirements for fire pumps. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 193/A 193M	(1996) Alloy-Steel and Stainless Steel

	Bolting Materials for High-Temperature Service
ASTM A 194/A 194M	(1996) Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
ASTM A 795	(1996) Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM B 42	(1996) Seamless Copper Pipe, Standard Sizes
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 135	(1996) Seamless Brass Tube
ASTM C 533	(1995) Calcium Silicate Block and Pipe Thermal Insulation
ASTM D 3308	(1991a) PTFE Resin Skived Tape
ASTM F 436	(1993) Hardened Steel Washers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(1986; R 1994) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA-01	(1995) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA ANSI/AWWA C110/A21.10	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids

AWWA ANSI/AWWA C111/A21.11	(1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA ANSI/AWWA C151/A21.51	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C500	(1993; C500) Metal-Sealed Gates Valves for Water Supply Service
AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825a	(1998) Approval Guide Fire Protection
FM P7825b	(1998) Approval Guide Electrical Equipment

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 20	(1996; Errata; TIA 96-1) Installation of Centrifugal Fire Pumps
NFPA 24	(1995) Installation of Private Fire Service Mains and Their Appurtenances
NFPA 37	(1997) Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	(1996; Errata 96-4) National Electrical Code
NFPA 1963	(1993) Fire Hose Connections

UNDERWRITERS LABORATORIES (UL)

UL 80	(1996) Steel Inside Tanks for Oil-Burner Fuel
UL 142	(1993; Rev Apr 1995) Steel Aboveground Tanks for Flammable and Combustible Liquids
UL 262	(1994; Rev thru Apr 1997) Gate Valves for Fire-Protection Service
UL 448	(1994; Rev Jun 1995) Pumps For Fire-Protection Service

UL 789	(1993; Rev Feb 1994) Indicator Posts for Fire-Protection Service
UL 1247	(1995; Rev thru May 1997) Diesel Engines For Driving Centrifugal Fire Pumps
UL Fire Prot Dir	(1997) Fire Protection Equipment Directory

1.2 GENERAL REQUIREMENTS

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NOTE: The complete design of the fire pump installation must be indicated on the project drawings. All piping, valves, and equipment including sizes will be indicated.

Horizontal fire pumps will be provided only under a positive head and will not be used where a static suction or lift may be involved.

Vertical shaft pumps should take suction from a reliable source which serves a wet pit. Velocities of wet pits and approach channels serving vertical shaft turbine fire pumps will not exceed 0.3 m/s (1 ft/sec). Vertical shaft pumps mounted over and taking suction from tanks will be avoided.

Hose stream demands must be accounted for in the design so that the pump output will not be affected due to low suction pressure and deprive the sprinklers of water.

The size of the suction pipe should be such that the velocity does not exceed 4.5 m/s (15 ft/sec) when pumps are operating at 150% capacity.

If required, backflow preventers will be installed on the discharge side of the pump.

Pumps will be located at or above surrounding ground level to avoid any possible impairment due to flooding.

When pump has a diesel-engine-driver, the pump room or pump house will be protected by automatic sprinklers.

Design will include provision for heating if temperature can fall below freezing. Ventilation should be provided to limit room temperature to 6 degrees C (10 degrees F) rise above outside temperature during hot weather.

Design will indicate pump units and base mounted on

a raised reinforced concrete pad that is an integral part of an adequately reinforced and supported concrete floor.
****

1.2.1 Standard Product

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate equipment that has been in satisfactory operation at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the jobsite.

1.2.2 Description

Fire pump, piping and associated equipment shall be provided complete and ready for operation. The fire pump shall be [horizontal] [vertical shaft turbine type] centrifugal fire pump. The fire pump shall be [electric motor driven] [diesel engine driven] fire pump. Fire pump, appurtenances and installation shall conform to NFPA 20, unless more stringent requirements are specified herein or are indicated on the drawings. In NFPA 20, the advisory provisions including those listed in the appendix shall be considered mandatory; reference to the authority having jurisdiction shall be interpreted to mean the Contracting Officer. Devices and equipment for fire protection service shall be UL listed UL Fire Prot Dir or FM approved FM P7825a and FM P7825b.

1.2.3 Sequence of Operation

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NOTE: Fire pumps should be automatically started by a change in water pressure. See recommended pressure settings listed in the appendix of NFPA 20, A-11-4, "Fire Pump Operation."

Additionally, there are conditions where pumps should be automatically started by a sprinkler or fire protection system waterflow. These are where the water pressure fluctuates so much that a satisfactory cut-in pressure cannot be obtained; where the hydraulic conditions and pump location are such that opening of a moderate number of sprinklers does not cause an appreciable drop in pressure at the pump.

Manually stopping of fire pumps: There may be conditions when manually stopping of the fire pump is required instead of automatic stopping. For example, NFPA 409, Standard on Aircraft Hangars, requires that fire pumps serving aircraft hangars be manually stopping only. For these special cases, Paragraph Sequence of Operation would require editing.
****

1.2.3.1 Pressure Maintenance Pump

Pressure maintenance pump shall operate when the system pressure drops to [115][_____] psi. Pump shall automatically stop when the system pressure reaches [125][_____] psi and after the pump has operated for the minimum pump run time specified herein.

1.2.3.2 Primary Fire Pump

Primary fire pump shall automatically operate when the pressure drops to [110][_____] psi. The fire pump shall automatically stop operating when the system pressure reaches [125][_____] psi and after the fire pump has operated for the minimum pump run time specified herein.

1.2.3.3 Secondary Fire Pump

Secondary fire pump shall operate at 10 psi increments, set below the primary fire pump starting pressure. The fire pump shall automatically stop running at [125][_____] psi and after the fire pump has operated for the minimum pump run time. Fire pumps shall be prevented from starting simultaneously and shall start sequentially at intervals of 5 to 10 seconds.

1.2.4 Safety Requirements

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NOTE: Provide adequate clearance and access space to safely install, test and maintain the fire pump system.

****

Coupling, rotating parts, gears, projecting equipment, etc. shall be fully enclosed or properly guarded so as to prevent possible injury to persons that come in close proximity of the equipment. The Contractor shall conduct testing of the fire pumps in a safe manner and ensure that all equipment is safely secured. Hoses and nozzles used to conduct flow tests shall be in excellent condition and shall be safely anchored and secured to prevent any misdirection of the hose streams.

1.2.5 Verification of Dimensions

The Contractor shall become familiar with all details of the work and verify all dimensions in the field. The Contractor shall notify the Contracting Officer of any discrepancy before performing the work.

1.2.6 Electrical Work

Electric motor and controls shall be in accordance with NFPA 20 and NFPA 70, unless more stringent requirements are specified herein or are indicated on the drawings. Electrical wiring and associated equipment shall be provided in accordance with NFPA 20 and Section 16415 ELECTRICAL WORK, INTERIOR.

1.2.7 Factory Tests

Fire pump shall be tested by the manufacturer before shipment to provide detailed performance data and to demonstrate its compliance with the specifications.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. Unless otherwise indicated, 6 copies of each item shall be submitted. Submittals, except Fire Protection Engineer's Qualifications shall be submitted concurrently as a complete package. Each submittal shall be certified in writing by the Fire Protection Engineer. The Fire Protection Engineer shall certify that the submittal is complete, that the equipment and equipment arrangement meets contract requirements, and that the proposed system is coordinated and compatible with all other equipment connected to the system, the physical space, and the power sources. The Fire Protection Engineer shall sign and date all shop drawing submittal sheets and revisions. The submittal will be reviewed by the U.S. Army Engineer District Fire Protection Engineer.

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES.

SD-01 Data

Equipment; GA.

Manufacturer's catalog data for each separate piece of equipment proposed for use in the system. Catalog data shall indicate the name of the manufacturer of each item of equipment, with data annotated to indicate model to be provided. In addition, a complete equipment list which includes equipment description, model number and quantity shall be provided. Catalog data for material and equipment shall include, but not be limited to, the following:

a. Fire pumps, drivers and controllers including manufacturer's certified shop test characteristic curve for each pump. Shop test curve may be submitted after approval of catalog data but shall be submitted prior to the final tests.

b. Pressure maintenance pump and controller.

c. Piping and fittings.

d. Valves, including gate, check, globe and relief valves.

e. Gauges.

f. Hose valve manifold test header and hose valves.

g. Flow meter.

h. Restrictive orifice union.

i. Associated devices and equipment.

Final Test; [_____].

A written request for scheduling of the final test at least [15] [_____] days prior to the date that the final acceptance test is to take place and after successful completion of the preliminary tests.

SD-04 Drawings

Pump Room, Equipment and Piping; GA.

Detailed drawings consisting of a detailed plan view, detailed elevations and sections of the pump room, equipment and piping, drawn to a scale of not less than 1/2 inch = 1 foot. Drawings shall indicate equipment, piping, and associated pump equipment to scale. All clearance, such as those between piping and equipment; between equipment and walls, ceiling and floors; and for electrical working distance clearance around all electrical equipment shall be indicated. Drawings shall include a legend identifying all symbols, nomenclatures, and abbreviations. Drawings shall indicate a complete piping and equipment layout including elevations and/or section views of the following:

a. Fire pumps, controllers, piping, valves, and associated equipment.

b. Sensing line for each pump including the jockey pump.

c. Engine fuel system for diesel driven pumps.

d. Engine cooling system for diesel driven pumps.

e. Pipe hangers and sway bracing including support for diesel muffler and exhaust piping.

f. Restraint of underground water main at [entry-point] [entry-and exit-points] to the building.

A one-line schematic diagram indicating layout and sizes of all piping, devices, valves and fittings.

A complete point-to-point connection drawing of the pump power, control and alarm systems, as well as interior wiring schematics of each controller.

As-Built Drawings; FIO.

Detailed drawings updated to reflect as-built conditions after all associated work is completed, on reproducible full-size mylar film, no later than 10 working days after completion of the Final Tests. Each as-built drawing shall have a title block similar to the contract drawings.

SD-06 Instructions

Framed Instructions; FIO.

Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for safe operation, sequence of operation, and procedures for safely starting and stopping the system, prepared in typed form, framed under glass or in laminated plastic. Instructions shall be posted where directed by the Contracting Officer. Wiring and control diagrams showing the complete layout of the entire system shall be framed under glass or in approved laminated plastic and posted near each controller as directed by the Contracting Officer. Proposed instructions, diagrams and other sheets shall be submitted for approval prior to posting. Framed instructions shall be posted before acceptance testing of the system.

SD-09 Reports

Field Tests; GA.

Test reports in booklet form showing all field tests and measurements taken during the preliminary and final testing, and documentation that proves compliance with the specified performance criteria, upon completion of the installation and final testing of the installed system. Each test report shall indicate the final position of the controls and pressure switches. The test reports shall include the description of the hydrostatic test conducted on the piping and flushing of the suction and discharge piping. A copy of the manufacturer's certified pump curve for each fire pump shall be included in the report.

SD-13 Certificates

Engineer's Qualifications; FIO.

Prior to all other submittals, certification that the Fire Protection Engineer is a registered Fire Protection Engineer or a Registered Engineer who has had at least 4 years experience in fire protection and fire pump installation design.

Preliminary Test; GA.

A signed and dated certificate that preliminary tests have been conducted, and that the fire pump installation is complete and ready to be placed in operation, prior to submitting a formal request for a final inspection and test. The certificate shall include the names, companies, phone numbers, and titles of persons conducting and witnessing the test, including the required manufacturer's representatives. Complete test procedures, as well as results and readings taken during the preliminary tests shall be included.

Piping; [_____].

A signed statement from the piping manufacturer certifying that the piping meets requirements specified. The statement shall be signed and dated after the award of this contract, shall include the name of the project, and shall list the specific requirements which are being certified.

SD-18 Records

Test Procedures; GA.

Detailed test procedures for testing the fire pump system, [60] [_____] days prior to performing the pump tests.

SD-19 Operation and Maintenance Manuals

Fire Pumps; [_____].

Operating instructions outlining step-by-step procedures required for fire pump startup, operation and shutdown shall be provided. The instructions shall include the manufacturer's name, model number, catalog cuts, diagrams, drawings, parts list, and descriptive data covering the proper operation and testing.

Six complete copies of maintenance instructions listing routine maintenance procedures and frequencies, possible breakdowns and repairs, troubleshooting guides, a complete list of parts and current sources, and recommended spare parts to be kept on hand. The instructions shall include simplified diagrams for the system as installed.

1.4 MANUFACTURER'S SERVICES

The Contractor shall obtain the services of the fire pump manufacturer, the fire pump controller manufacturer, and the diesel engine driver manufacturer (when provided) or their representative. The persons providing this service shall be factory-trained, shall be experienced in the installation, adjustment, and operation of the equipment and shall supervise the installation, the adjustments, and the testing of equipment. The persons providing the manufacturer service shall be present during the preliminary and final tests and shall assist in the testing of the equipment.

1.5 DELIVERY AND STORAGE

Equipment delivered to the site or placed in storage shall be protected from weather, humidity and temperature variations, dirt, dust, and other contaminants.

PART 2 PRODUCTS

2.1 FIRE PUMP

Fire pump shall be [electric motor driven] [diesel engine driven]. Each pump capacity shall be rated at [_____] gpm with a rated net pressure of [_____] psi. Fire pump shall furnish not less than 150 percent of rated flow capacity at not less than 65 percent of rated net pressure. Pump shall be centrifugal [horizontal split case] [vertical turbine] fire pump. Horizontal pump shall be equipped with automatic air release devices. The maximum rated pump speed shall be 2100 rpm when driving the pump at rated capacity. Pump shall conform to the requirements of UL 448. Fire pump discharge and suction gauges shall be oil-filled type.

2.2 ELECTRIC MOTOR DRIVER

****

NOTE: The design of the power supply to the electric drive fire pumps will comply with Chapter 6 of NFPA 20 and to NFPA 70. The fire pump power supply and fire pump power supply circuits and feeders will be indicated and detailed on the drawings.

Power supply protective devices installed in the power supply circuits and in the fire pump feeder

circuits will be designed not to open at the sum of the locked rotor currents (continuous) of the fire pump motor and any other maximum loads on the circuit per NFPA 20.

Fire pump feeder circuit conductors will be physically routed outside of the building(s), excluding the electrical switchgear room and the pump room. When the fire pump feeder conductors must be routed through buildings, they will be buried or enclosed by 50 mm (2 inches) of concrete or equivalent fire-rated construction.

Designer will indicate and detail the grounding of the controller per NFPA 20.
****

Motor shall comply to NEMA MG 1 and be marked as complying with NEMA Design B standards. Motor horsepower shall be of sufficient size so that the nameplate horsepower rating will not be exceeded throughout the entire published pump characteristic curve. The motor and fire pump controller shall be fully compatible.

2.3 DIESEL ENGINE DRIVER

****
NOTE: Ambient design temperature will be based on 6 degrees C (10 degrees F) above the 2-1/2 percent summer design dry bulb temperature in TM 5-785 Engineering Weather Data.
****

Diesel engine driver shall conform to the requirements of UL 1247 and shall be UL listed UL Fire Prot Dir or FM approved FM P7825a and FM P7825b for fire pump service. Driver shall be of the make recommended by the pump manufacturer. The engine shall be closed circuit, liquid-cooled [with raw water heat exchanger] [with radiator and engine-driven fan]. Diesel engine shall be electric start type taking current from 2 battery units. Engine shall be equipped with a fuel in-line filter-water separator. Engine conditions shall be monitored with engine instrumentation panel that has a tachometer, hour meter, fuel pressure gauge, lubricating oil pressure gauge, water temperature gauge, and ammeter gauge. Engine shall be connected to horizontal-shaft pump by flexible couplings. For connections to vertical-shaft fire pumps, right-angle gear drives and universal joints shall be used.

2.3.1 Engine Horsepower

Engine shall have adequate horsepower to drive the pump at all conditions of speed and load over the full range of the pump performance curve. The horsepower rating of the engine driver shall be as recommended by the pump manufacturer and shall be derated for temperature and elevation in accordance with NFPA 20. Ambient temperature at the pump location shall be [_____] degrees F. Site elevation shall be [_____] feet above mean sea level (MSL).

2.3.2 Exhaust System External to Engine

****

NOTE: Indicate and specify adequate safeguards for exhaust piping passing through walls and roof. Provide suitable thimble and clearance when pipe passes through combustible construction or roofing.

****

Exhaust system shall comply with the requirements of NFPA 20 and NFPA 37. An exhaust muffler shall be provided for each diesel engine driver to reduce noise levels less than 95 dBA. A flexible connector with flange connections shall be provided at the engine. Flexible sections shall be stainless steel suitable for diesel-engines exhaust gas at 1000 degrees F.

2.3.2.1 Steel Pipe and Fittings

ASTM A 53, Schedule 40, black steel, welding end connections. ASME B16.9 or ASME B16.11 welding fittings shall be of the same material and weight as the piping.

2.3.2.2 Flanges

ASME B16.5, Class 300. Flanges shall be provided at connections to diesel engines, exhaust mufflers, and flexible connections. Gaskets shall be ASME B16.21, composition ring, 0.0625 inch thick. ASTM A 193/A 193M, Grade B8 bolts and ASTM A 194/A 194M, Grade 8 nuts shall be provided.

2.3.2.3 Piping Insulation

Products containing asbestos will not be permitted. Exhaust piping system including the muffler shall be insulated with ASTM C 533 calcium silicate insulation, minimum of 3 inches thick. Insulation shall be secured with not less than 0.375 inch width Type 304 stainless steel bands spaced not more than 8 inches on center. An aluminum jacket encasing the insulation shall be provided. The aluminum jacket shall have a minimum thickness of 0.016 inches, a factory-applied polyethylene and kraft paper moisture barrier on the inside surface. The jacket shall be secured with not less than 0.5 inch wide stainless steel bands, spaced not less than 8 inches on centers. Longitudinal and circumferential seams of the jacket shall be lapped not less than 3 inches. Jackets on horizontal line shall be installed so that the longitudinal seams are on the bottom side of the pipe. The seams of the jacket for the vertical lines shall be placed on the off-weather side of the pipe. On vertical lines, the circumferential seams of the jacket shall overlap so the lower edge of each jacket overlaps the upper edge of the jacket below.

2.4 NAMEPLATES AND MARKINGS

Pump and motor shall have standard nameplates securely affixed in a conspicuous place and easy to read. Fire pump shall have nameplates and markings in accordance with UL 448. Diesel driver shall have nameplate and markings in accordance with UL 1247. Electric motor nameplates shall provide the minimum information required by NFPA 70, Section 430-7.

2.5 FIRE PUMP CONTROLLER

Controller shall be the automatic type and UL listed UL Fire Prot Dir or FM approved FM P7825a and FM P7825b for fire pump service. Pump shall be arranged for automatic start and stop, and manual push-button stop.

Automatic stopping shall be accomplished only after all starting causes have returned to normal and after a minimum pump run time has elapsed. Controllers shall be completely terminally wired, ready for field connections, and mounted in a [NEMA Type 2 drip-proof] [NEMA Type 4 watertight and dust tight] enclosure arranged so that controller current carrying parts will not be less than 12 inches above the floor. Controller shall be provided with voltage surge arresters installed per NFPA 20. Controller shall be equipped with a bourdon tube pressure switch or a solid state pressure switch with independent high and low adjustments, automatic starting relay actuated from normally closed contacts, visual alarm lamps and supervisory power light. Controller shall be equipped with a thermostat switch with adjustable setting to monitor the pump room temperature and to provide an alarm when temperatures falls below 40 degrees F [Controller shall be equipped with a sequential start timer/relay feature to start multiple fire pumps in sequence.] [The controller shall be factory-equipped with a heater operated by thermostat to prevent moisture in the cabinet.]

2.5.1 Controller for Electric Motor Driven Fire Pump

****

NOTE: Designer will determine requirement for across-the-line or reduced voltage starting. If reduced voltage starting is needed, designer must determine most suitable type or types. Selections should be based on the motor size, electrical system capacity and characteristics, etc. Fire pumps that are served by back-up generators should be equipped with auto-transformer reduced voltage type controller.

****

Controller shall monitor pump running, loss of a phase or line power, phase reversal, [low reservoir] and pump room temperature. Alarms shall be individually displayed in front of panel by lighting of visual lamps. Each lamp shall be labeled with rigid etched plastic labels. Controller shall be equipped with terminals for remote monitoring of pump running, pump power supply trouble (loss of power or phase and phase reversal), and pump room trouble (pump room temperature [and low reservoir level]), and for remote start. Limited service fire pump controllers are not permitted, except for fire pumps driven by electric motors rated less than 15 hp. Controller shall be equipped with a 7-day electric pressure recorder with 24-hour spring wound back-up. The pressure recorder shall provide a readout of the system pressure from 0 to 300 psi, time, and date. Controller shall require the pumps to run for ten minutes for pumps with driver motors under 200 horsepower and for 15 minutes for pumps with motors 200 horsepower and greater, prior to automatic shutdown. The controller shall be equipped with an externally operable isolating switch which manually operates the motor circuit. Means shall be provided in the controller for measuring current for all motor circuit conductors. Controller shall be [across the line] [auto-transformer] [wye-delta, open circuit transition] [wye-delta, closed circuit transition] starting type. Controller shall be designed [for [_____] HP at [_____] volts] [as indicated]. Controller [and transfer switch] shall have a short circuit rating [of [_____] amps r.m.s. symmetrical at [_____] volts a.c.] [as indicated]. [An automatic transfer switch (ATS) shall be provided for each fire pump. The ATS shall comply with NFPA 20 and shall be specifically listed for fire pump service. The ATS shall transfer source of power to the alternate source upon loss of normal power.]

2.5.2 Controller for Diesel Engine Driven Fire Pump

****
NOTE: Pump alarms will be constantly monitored and will usually require transmission to a constantly attended location. Pump alarms may be monitored by the building alarm system or base fire reporting system. Designer will indicate and specify remote alarm transmission devices, controls, conductors, conduit, connections, etc. Pump running, loss of pump power, and pump room trouble alarms must be remotely transmitted for electric fire pumps. Pump running, main switch mis-set, engine trouble, pump room trouble will be remotely transmitted for diesel fire pumps. Designer should coordinate transmission of alarms with the base fire department.
****

Controller shall require the pump to run for 30 minutes prior to automatic shutdown. Controller shall be equipped with two battery chargers; two ammeters; two voltmeters, one for each set of batteries. Controller shall automatically alternate the battery sets for starting the pumps. Controller shall be equipped with the following supervisory alarm functions:

a. Engine Trouble (individually monitored)

   (1) Engine overspeed

   (2) Low Oil Pressure

   (3) High Water Temperature

   (4) Engine Failure to Start

   (5) Battery

   (6) Battery Charger/AC Power Failure

b. Main Switch Mis-set

c. Pump Running

d. Pump Room Trouble (individually monitored)

   (1) Low Fuel

   (2) Low Pump Room Temperature

   (3) Low Reservoir Level

Alarms shall be individually displayed in front of panel by lighting of visual lamps, except that individual lamps are not required for pump running and main switch mis-set. Controller shall be equipped with a 7-day electric pressure recorder with 24-hour spring wound back-up mounted inside the controller. The pressure recorder shall provide a readout of the system pressure from 0 to 300 psi, time, and date. The controller shall be equipped with an audible alarm which will activate upon any engine trouble or pump room trouble alarm condition and alarm silence switch. Controller shall be equipped with terminals for field connection of a remote alarm for main switch mis-set, pump running, engine trouble and pump room trouble; and terminals for remote start. When engine emergency overspeed device operates, the controller shall cause the engine to shut down without time delay and lock out until manually reset.

2.6 BATTERIES

Batteries for diesel engine driver shall be sealed lead acid or lead calcium batteries. Batteries shall be mounted in a steel rack with non-corrosive, non-conductive base, not less than 12 inches above the floor.

2.7 PRESSURE SENSING LINE

A completely separate pressure sensing line shall be provided for each fire pump and for the jockey pump. The sensing line shall be arranged in accordance with Figure A-7-5.2.1. of NFPA 20. The sensing line shall be 1/2 inch H58 brass tubing complying with ASTM B 135. The sensing line shall be equipped with two restrictive orifice unions each. Restricted orifice unions shall be ground-face unions with brass restricted diaphragms drilled for a 3/32 inch orifice. Restricted orifice unions shall be mounted in the horizontal position, not less than 5 feet apart on the sensing line. Two test connections shall be provided for each sensing line. Test connections shall consist of two brass 1/2 inch globe valves and 1/4 inch gauge connection tee arranged per NFPA 20. One of the test connections shall be equipped with a 0 to 200 psi water oil-filled gauge. Sensing line shall be connected to the pump discharge piping between the discharge piping control valve and the check valve.

2.8 PRESSURE MAINTENANCE (JOCKEY) PUMP

Pressure maintenance pump shall be electric motor driven, [horizontal shaft] [or] [in-line vertical shaft], centrifugal type with a rated discharge of [10][_____] gpm at [125][_____] psig. Pump shall draft [from the suction supply side of the suction pipe gate valve of the fire pump] [as indicated] and shall discharge into the system at the downstream side of the pump discharge gate valve. An approved indicating gate valve of the outside screw and yoke (O.S.&Y.) type shall be provided in the maintenance pump discharge and suction piping. Oil-filled water pressure gauge and approved check valve in the maintenance pump discharge piping shall be provided. Check valve shall be swing type with removable inspection plate.

2.8.1 Pressure Maintenance Pump Controller

Pressure maintenance pump controller shall be arranged for automatic and manual starting and stopping and equipped with a "manual-off-automatic" switch. The controller shall be completely terminally wired, ready for field connections, and wall-mounted in a NEMA Type 2 drip-proof enclosure. The controller shall be equipped with a bourdon tube pressure switch or a solid state pressure switch with independent high and low adjustments for automatic starting and stopping. A sensing line shall be provided connected to the pressure maintenance pump discharge piping between the control valve and the check valve. The sensing line shall conform to paragraph, PRESSURE SENSING LINE. The sensing line shall be completely separate from the fire pump sensing lines. An adjustable run timer shall be provided to prevent frequent starting and stopping of the pump motor. The run timer shall be set for [2] [_____] minutes.

2.9 DIESEL FUEL SYSTEM EXTERNAL TO ENGINE

****

NOTE: Fuel supply system for the diesel engine must be shown and detailed on the drawings. Design will follow the recommended design listed in the appendix of NFPA 20. Fuel tanks will be sized to have a capacity at least 5.1 liters per kilowatt (1 gallon per horsepower) plus 10%. Larger tanks or a reserve supply with transfer facilities may be needed where prompt refilling is unlikely. Provide a separate fuel tank for each pump. Tanks will be located in the pump room. For tanks located above the lowest story, cellar or basement, the designer will provide proper fuel containment such as a sealed containment curbs or walls that will contain the entire volume of each tank. Delete low reservoir level alarm where it is not needed.

****

Fuel system shall be provided that meets all requirements and advisory provisions of NFPA 20 and NFPA 37. The fuel tank vent piping shall be equipped with screened weatherproof vent cap. Vents shall be extended to the outside. Each tank shall be equipped with a fuel level gauge. Flexible bronze or stainless steel piping connectors with single braid shall be provided at each piping connection to the diesel engine. Supply, return, and fill piping shall be steel piping, except supply and return piping may be copper tubing. Fuel lines shall be protected against mechanical damage. Fill line shall be equipped with 16 mesh removable wire screen. Fill lines shall be extended to the exterior. A weatherproof tank gauge shall be mounted on the exterior wall near each fill line for each tank. The fill cap shall be able to be locked by padlock. The engine supply (suction) connection shall be located on the side of the fuel tank so that 5 percent of the tank volume provides a sump volume not useable by the engine. The elevation of the fuel tank shall be such that the inlet of the fuel supply line is located so that its opening is no lower than the level of the engine fuel transfer pump. The bottom of the tank shall be pitched 1/4 inch per foot to the side opposite the suction inlet connection, and to an accessible 1 inch plugged globe drain valve.

2.9.1 Steel pipe

ASTM A 53, hot-dipped zinc-coated, Schedule 40, threaded connections. Fittings shall be ASME B16.3, zinc-coated, threaded malleable iron fittings. Unions shall be ASME B16.39 zinc-coated, threaded unions.

2.9.2 Copper Tubing

ASTM B 88, Type K, soft annealed, with ASME B16.26 flared fittings.

2.9.3 Diesel Fuel Tanks

UL 80 or UL 142 for aboveground tanks.

2.9.4 Valves

An indicating and lockable ball valve shall be provided in the supply line adjacent to the tank suction inlet connection. A check valve shall be provided in fuel return line. Valves shall be suitable for oil service. Valves shall have union end connections or threaded end connections.

a. Globe valve: MSS SP-80 Class 125

b. Check valve: MSS SP-80, Class 125, swing check

c. Ball valve: Full port design, copper alloy body, 2-position lever handle.

2.10 PUMP BASE PLATE AND PAD

A common base plate shall be provided for each horizontal-shaft fire pump for mounting pump and driver unit. The base plate shall be constructed of cast iron with raised lip tapped for drainage or welded steel shapes with suitable drainage. Each base plate for the horizontal fire pumps shall be provided with a 1 inch galvanized steel drain line piped to the nearest floor drain. For vertical shaft pumps, pump head shall be provided with a cast-iron base plate and shall serve as the sole plate for mounting the discharge head assembly. Pump units and bases shall be mounted on a raised [4][6] inch reinforced concrete pad that is an integral part of the reinforced concrete floor.

2.11 ABOVEGROUND WATER PIPING

2.11.1 Pipe Sizes 2.5 Inches and Larger

2.11.1.1 Pipe

Piping shall be ASTM A 795, Weight Class STD (Standard), Schedule 40 (except for Schedule 30 for pipe sizes 8 inches and greater in diameter), Type E or Type S, Grade A; black steel pipe. Steel pipe shall be joined by means of flanges welded to the pipe or mechanical grooved joints only. Piping shall not be jointed by welding or weld fittings. Suction piping shall be galvanized on the inside per NFPA 20.

2.11.1.2 Flanges

Flanges shall be ASME B16.5, Class 150 flanges. Flanges shall be provided at valves, connections to equipment, and where indicated.

2.11.1.3 Gaskets

Gaskets shall be AWWA ANSI/AWWA C111/A21.11, cloth inserted red rubber gaskets.

2.11.1.4 Bolts

Bolts shall be ASTM A 193/A 193M, Grade B8. Bolts shall extend no less than three full threads beyond the nut with bolts tightened to the required torque.

2.11.1.5 Nuts

Nuts shall be ASTM A 194/A 194M, Grade 8.

2.11.1.6 Washers

Washers shall meet the requirements of ASTM F 436. Flat circular washers shall be provide under all bolt heads and nuts.

2.11.2 Piping Sizes 2 Inches and Smaller

2.11.2.1 Steel Pipe

Steel piping shall be ASTM A 795, Weight Class STD (Standard), Schedule 40, Type E or Type S, Grade A, zinc-coated steel pipe with threaded end connections. Fittings shall be ASME B16.39, Class 150, zinc-coated threaded fittings. Unions shall be ASME B16.39, Class 150, zinc-coated unions.

2.11.2.2 Copper Tubing

Copper tubing shall be ASTM B 88, Type L or K, soft annealed. Fittings shall be ASME B16.26, flared joint fittings. Pipe nipples shall be ASTM B 42 copper pipe with threaded end connections.

2.11.3 Pipe Hangers and Supports

Pipe hangers and support shall be UL listed UL Fire Prot Dir or FM approved FM P7825a and FM P7825b and shall be the adjustable type. Finish of rods, nuts, washers, hangers, and supports shall be zinc-plated after fabrication.

2.11.4 Valves

Valves shall be UL listed UL Fire Prot Dir or FM approved FM P7825a and FM P7825b for fire protection service. Valves shall have flange or threaded end connections.

2.11.4.1 Gate Valves and Control Valves

Gate valves and control valves shall be outside screw and yoke (O.S.&Y.) type which open by counterclockwise rotation. Butterfly-type control valves are not permitted.

2.11.4.2 Tamper Switch

****

NOTE: Provide tamper switches on control valves when preferred by the user or when valves are subject to tampering. An alternate allowed by NFPA is to lock OS& Y valves open with chain and padlock.

****

The suction control valves, the discharge control valves, and the by-pass control valves shall be equipped with valve tamper switches for monitoring by the fire alarm system.

2.11.4.3 Check Valve

Check valve shall be clear open, swing type check valve with flange or threaded inspection plate.

2.11.4.4 Relief Valve

****

NOTE: Piping of a relief valve back to the pump

suction connection should be avoided except when it is not possible to dispose of the discharge water. In such cases, the relief valve discharge piping tee connection to the suction should have its centerline plane perpendicular to the pump shaft. The tee connection should be at least 10 diameters from the pump suction flange.
****

Relief valve shall be [pilot operated] [or] [spring operated] type conforming to NFPA 20. A means of detecting water motion in the relief lines shall be provided where the discharge is not visible within the pump house.

2.11.4.5 Circulating Relief Valve

An adjustable circulating relief valve shall be provided for each fire pump in accordance with NFPA 20.

2.11.4.6 Suction Pressure Regulating Valve

****
NOTE: Delete suction pressure regulating valve unless required for the specific water supply.

When an oversized pump has been installed on a water distribution system, the pump should satisfy the demand without drawing the residual pressure of the water system below a safe level, which is normally between 69 kPa and 138 kPa (10 psi and 20 psi). A pilot-controlled, hydraulically-actuated, minimum suction pressure sustaining valve may be necessary when suction pressures can be drawn down to unsafe levels. These valves are provided on the discharge line of the fire pump. The pump suction pressure is monitored through a pressure line to the controlling mechanism of the regulating valve.
****

Suction pressure regulating valve shall be FM approved FM P7825a and FM P7825b. Suction pressure shall be monitored through a pressure line to the controlling mechanism of the regulating valve. Valve shall be arranged in accordance with the manufacturer's recommendations.

2.12 HOSE VALVE MANIFOLD TEST HEADER

****
NOTE: The design will include method of flow testing the fire pump and the suction supply piping. This should be accomplished by providing an exterior hose test header and a flow meter. The exterior test header is necessary for testing the condition of suction supply, valves and piping. Hydrants will not be used for this purpose. The design will clearly indicate the test arrangement. See NFPA 20, Figure A-2-14.2.1.

****

Hose valve test header shall be connected by ASME B16.5, Class 150 flange inlet connection. Hose valves shall be UL listed UL Fire Prot Dir or FM approved FM P7825a and FM P7825b bronze hose gate valves with 2.5 inch American National Fire Hose Connection Screw Standard Threads (NH) per NFPA 1963. The number of valves shall be per NFPA 20. Each hose valve shall be equipped with a cap and chain, and located no more than 3 feet and no less than 2 feet above grade.

2.13 FLOW METER

Meter shall be UL listed UL Fire Prot Dir or FM approved FM P7825a and FM P7825bas flow meters for fire pump installation with direct flow readout device. Flow meter shall be capable of metering any waterflow quantities between 50 percent and 150 percent of the rated flow of the pumps. The flow meter shall be arranged in accordance with Figure A-2-14.2.1 of NFPA 20. The meter throttle valve and the meter control valves shall be O.S.&Y. valves. Automatic air release shall be provided if flow meter test discharge is piped to the pump suction and forms a closed-loop meter arrangement as defined in Figure A-2-14.2.1 of NFPA 20.

2.14 PIPE SLEEVE

A pipe sleeve shall be provided at each location where piping passes through walls, ceilings, roofs, and floors, including pipe entering buildings from the exterior. Sleeves shall be grouted in position during construction. Sleeve shall be of sufficient length to pass through the entire thickness of the wall, ceilings, roofs and floors. Not less than 1 inch clearance shall be provided between pipe exterior surface and the interior of the sleeve, and between the tie rods and the interior of the sleeve. The space shall be firmly packed with mineral wool insulation and caulk at both ends with plastic waterproof cement which will dry to a firm but pliable mass, or with a segmented elastomeric seal. Where pipes pass through fire walls or fire floors, a fire seal shall be provided between the pipe and the sleeve in accordance with Section 07840 FIRESTOPPING. Sleeves in masonry and concrete walls, ceiling, roofs and floors shall be hot-dip galvanized steel, ductile-iron, or cast-iron. Other sleeves shall be galvanized steel sheet pipe not less than 0.90 psf.

2.15 ESCUTCHEON (WALL) PLATES

Escutcheon plates shall be one-piece or split-hinge type metal plates and shall be provided for piping passing through floors, walls, and ceiling in exposed areas. In finished areas, plates shall be polished stainless steel or chromium-plated finish on copper alloy. In unfinished areas, plates shall have painted finish. Plates shall be secured in position.

2.16 UNDERGROUND PIPING

2.16.1 Pipe and Fittings

Underground piping and piping under the building slab shall be ductile-iron pipe and fittings. Piping shall be AWWA ANSI/AWWA C151/A21.51 ductile-iron pipe with AWWA ANSI/AWWA C110/A21.10 fittings and shall conform to NFPA 24. Piping beyond 5 feet of the building shall be provided under Section 02510 WATER DISTRIBUTION SYSTEM.

2.16.2 Valves

Valves shall be gate valves conforming to AWWA C500 or UL 262. Valves shall have cast-iron body and bronze trim. Valve shall open by counterclockwise rotation.

2.16.2.1 Valve Boxes

Except for post indicator valves, all underground valves shall be provided with an adjustable cast-iron or ductile iron valve box of a size suitable for the valve on which the box is to be used, but not less than 5.25 inches in diameter. The box shall be coated with bituminous coating. A cast-iron or ductile-iron cover with the word "WATER" cast on the cover shall be provided for each box.

2.16.2.2 Post Indicator Valves (PIVS)

****

NOTE: Air Force requires tamper switches on the PIVs.

****

Valves shall conform to UL 262. Indicator post shall conform to UL 789. PIVs shall have operating nut and removable operating handle. PIVs shall be lockable with [standard padlock.] [a tamper switch.] PIVs shall be painted with one coat of primer and two coats of red enamel paint.

2.16.3 Buried Utility Warning and Identification Tape

Detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping shall be provided for all buried piping. Tape shall be detectable by an electronic detection instrument. Tape shall be color-coded for the utility involved and imprinted in bold black letters continuously and repeatedly over the entire tape length. Warning and identification shall be "CAUTION BURIED WATER PIPING BELOW" or similar wording. Code and lettering shall be permanent and unaffected by moisture and other substances contained in the trench backfill material. Tape shall be buried at a depth of 12 inches below the top surface of earth or the top surface of the subgrade under pavement.

2.17 CHLORINATING AGENTS

Chlorinating agent must comply with one of the following.

2.17.1 Liquid Chlorine

AWWA B301

2.17.2 Calcium Hypochlorite and Sodium Hypochlorite

AWWA B300

PART 3 EXECUTION

3.1 INSTALLATION

Installation, workmanship, fabrication, assembly, erection, examination, inspection and testing shall be in accordance NFPA 20, except as modified herein. In addition, the fire pump and engine shall be installed in accordance with the written instructions of the manufacturer.

3.2 PIPE AND FITTINGS

Piping shall be inspected, tested and approved before burying, covering, or concealing. Fittings shall be provided for changes in direction of piping and for all connections. Changes in piping sizes shall be made using tapered reducing pipe fittings. Bushings shall not be used.

3.2.1 Cleaning of Piping

Interior and ends of piping shall be clean and free of any water or foreign material. Piping shall be kept clean during installation by means of plugs or other approved methods. When work is not in progress, open ends of the piping shall be securely closed so that no water or foreign matter will enter the pipes or fittings. Piping shall be inspected before placing in position.

3.2.2 Threaded Connections

Jointing compound for pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread tape conforming to ASTM D 3308 and shall be applied to male threads only. Exposed ferrous pipe threads shall be provided with one coat of zinc molybdate primer applied to a minimum of dry film thickness of 1 mil.

3.2.3 Pipe Hangers and Supports

Additional hangers and supports shall be provided for concentrated loads in aboveground piping, such as for valves and risers.

3.2.3.1 Vertical Piping

Piping shall be supported at each floor, at not more than 10 foot intervals.

3.2.3.2 Horizontal Piping

Horizontal piping supports shall be spaced as follows:

MAXIMUM SPACING (FEET)

Nominal Pipe Size (inches)	1 and Under	1.25	1.5	2	2.5	3	3.5	4	5	6+
Copper Tube	6	7	8							
Steel Pipe	7	8	9	10	11	12	13	14	16	17

3.2.4 Underground Piping

Installation of underground piping and fittings shall conform to NFPA 24. Joints shall be anchored in accordance with NFPA 24. Concrete thrust block shall be provided at elbow where pipe turns up towards floor, and the pipe riser shall be restrained with steel rods from the elbow to the flange above the floor. After installation per NFPA 24, rods and nuts shall be thoroughly cleaned and coated with asphalt or other corrosion-retard material approved by the Contracting Officer. Minimum depth of cover shall be 3 feet.

3.3 ELECTRICAL WORK

Except as modified herein, interior wiring methods shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR; exterior wiring methods shall be in accordance with Section 16375 ELECTRICAL DISTRIBUTION SYSTEMS, UNDERGROUND or Section 16370 ELECTRICAL DISTRIBUTION SYSTEMS, AERIAL as appropriate.

3.4 FIELD PAINTING AND FINISHING

Field painting and finishing shall conform to the requirements specified in Section 09900 PAINTING, GENERAL. Piping shall be provided with plastic labels of standard manufacture to identify piping as FIRE PUMP DISCHARGE, FIRE PUMP SUCTION, FIRE PUMP BYPASS, FIRE PUMP TEST HEADER, TO SYSTEM, and RELIEF VALVE DISCHARGE. Labels shall have red letters 1 inch high, 1/4 inch brush stroke, on white background.

3.5 INSTRUCTING OPERATING PERSONNEL

Upon completion of the work and at a time designated by the Contracting Officer, the Contractor shall provide, for a period of not less than one 8-hour working day, the services of experienced technicians regularly employed by the manufacturer of the fire pump, the fire pump controller, and the pump drivers to instruct Government operating personnel in the proper operation, inspection, testing, and maintenance of the equipment. Manufacturer's representatives who were present during the final tests shall be present and shall conduct or assist in the instruction.

3.6 FLUSHING

The fire pump suction and discharge piping shall be flushed at 120 percent of rated capacity of each pump. Where the pump installation consists of more than one pump, the flushing shall be the total quantity of water flowing when all pumps are discharging at 120 percent of their rated capacities. The new pumps may be used to attain the required flushing volume. Flushing operations shall continue until water is clear, but not less than 10 minutes. The Contractor shall submit a signed and dated flushing certificate before requesting field testing.

3.7 FIELD TESTS

3.7.1 Hydrostatic Test

Piping shall be hydrostatically tested at 225 psig for a period of 2-hours, or at least 50 psi in excess of the maximum pressure, when the maximum pressure in the system is in excess of 175 psi.

3.7.2 Preliminary Test

The fire pump manufacturer, the fire pump controller manufacturer, and the diesel engine manufacturer (when supplied) or their representative shall witness the complete operational testing of the fire pump and drivers. Fire pumps, drivers and equipment shall be thoroughly inspected and tested to insure that the system is correct, complete, and ready for operation. Tests shall ensure that pumps are operating at rated capacity, pressure and speed. Tests shall include manual starting and running to ensure proper operation and to detect leakage or other abnormal conditions, flow testing, automatic start testing, testing of automatic settings, sequence of operation check, test of required accessories; test of pump alarms devices and supervisory signals, test of pump cooling, operational test of relief valves, and test of automatic power transfer, if provided. Pumps shall run without abnormal noise, vibration or heating. If any component or system was found to be defective, inoperative, or not in compliance with the contract requirements during the tests and inspection, the corrections shall be made and the entire preliminary test shall be repeated. All test results and readings shall be recorded during the tests and signed by the witnessing manufacturer's representative.

3.7.3 Final Test

The Engineer District Fire Protection Engineer will witness the final tests. The Contractor shall take all readings and measurements. An experienced technician regularly employed by the pump installer shall be present during the test. The pump manufacturer, the fire pump controller manufacturer, and the diesel engine manufacturer (when supplied), or their representative shall be present for the final tests. Where pumps are diesel driven, an experienced technician employed by the engine manufacturer capable of demonstrating engine trouble alarms and operating features shall be present. The Contractor shall be responsible for repairing any damage caused by hose streams or other aspects of the test. The final acceptance test shall include the following:

3.7.3.1 Inspection

Thorough inspection of the fire pump installation, including visual observation of the pump while running shall be conducted. There shall be no excessive vibration, leaks (oil or water), unusual noises, overheating, or other potential problems. Inspection shall include piping and equipment clearance, access, supports, and guards.

3.7.3.2 Flow Tests

Flow tests using the test header, hoses and playpipe nozzles shall be conducted. Flow tests shall be performed at churn (no flow), 75, 100, 125 and 150 percent capacity for each pump and at full capacity of the pump installation. Flow readings shall be taken from each nozzle by means of a calibrated pitot tube with gauge or other approved measuring equipment. Rpm, suction pressure and discharge pressure reading shall be taken as part of each flow test. Voltage and ampere readings shall taken on each phase as part of each flow test for electric-motor driven pumps.

3.7.3.3 Starting Tests

Pumps shall be tested for automatic starting and sequential starting. Setting of the pressure switches shall be tested when pumps are operated by pressure drop. Tests may be performed by operating the test connection on the pressure sensing lines. As a minimum, each pump shall be started automatically 10 times and manually 10 times, in accordance with NFPA 20. Tests of engine-driven pumps shall be divided equally between both set of batteries. The fire pumps shall be operated for a period of a least 10 minutes for each of the starts; except that electric motors over 200 horsepower shall be operated for at least 15 minutes and shall not be started more than 2 times in 10 hours.

3.7.3.4   Battery Changeover

Diesel driven fire pumps shall be tested for automatic battery changeover in event of failure of initial battery units.

3.7.3.5   Alarms

All pump alarms, both local and remote, shall be tested. Supervisory alarms for diesel drivers shall be electrically tested for low oil pressure, high engine jacket coolant temperature, shutdown from overspeed, battery failure and battery charger failure.

3.7.3.6   Miscellaneous

Valve tamper switches shall be tested. Pressure recorder operation relief valve settings, valve operations, operation and accuracy of meters and gauges, and other accessory devices shall be verified.

3.7.3.7   Alternate Power Source

On installations with an alternate source of power and an automatic transfer switch, loss of primary power shall be simulated and transfer shall occur while the pump is operating at peak load. Transfer from normal to emergency source and retransfer from emergency to normal source shall not cause opening of overcurrent devices in either line. At least half of the manual and automatic starting operations listed shall be performed with the fire pump connected to the alternate source.

3.7.4   Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, the Contractor shall performed corrective actions and repeat the tests. Tests shall be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.7.5   Test Equipment

The Contractor shall provide all equipment and instruments necessary to conduct a complete final test, including 2.5 inch diameter hoses, playpipe nozzles, pitot tube gauges, portable digital tachometer, voltage and ampere meters, and calibrated oil-filled water pressure gauges. The Contractor shall provide all necessary supports to safely secure hoses and nozzles during the test. The [Government will] [Contractor shall] furnish water for the tests.

3.7.6   Test Documentation

Contractor shall supply a copy of the manufacturer's certified curve for each fire pump at the time of the test. The Contractor shall record all test results and plot curve of each pump performance during the test. The Contractor shall provide complete pump acceptance test data of each fire pump. The pump acceptance test data shall be on forms that give the detail pump information such as that which is indicated in Figure A-11-2.6.3(f) of NFPA 20. The Contractor shall provide pump test data sheet in a properly labeled three ring binder.

3.8   DISINFECTION

****

NOTE: Provide specific procedures to ensure that existing piping, piping and pumps specified in this Section and any new or existing fire protection systems are disinfected as a complete system so that the disinfection is effective. If the entire fire water system is isolated form the domestic water system by means of a reduced pressure backflow prevention assembly or if the fire water system is not connected to the domestic water piping, this paragraph should be deleted.
****

Begin disinfection only after installation of the pumps piping and other associated work, including hydrostatic test, is complete. Thoroughly flush the pumps and all piping to be disinfected with potable water until there is no visible sign of dirt or other residue. Water chlorination, using either hypochlorites or liquid chlorine as the chlorinating material, shall be in accordance with AWWA M20. At a constant rate of 50 parts per million (ppm) into the piping, feed the hypochlorites (using a hypochlorinator) or liquid chlorine (through a solution-fed chlorinator and booster pump). Feed the chlorinating material until the entire system is filled. Leave the solution in the pumps and piping a minimum of 24 hours. Open and close each valve in the system several times during this 24 hour period. If, after 24 hours, the residual solution contains less than 25 ppm chlorine, flush the piping again with domestic water, then repeat the above procedure until 25 ppm chlorine is present after the 24 hour holding period. When the residual chlorine is adequate, take samples of water in disinfected containers from several locations selected by the Contracting Officer. Test samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA-01. Use either the multiple-tube fermentation technique or the membrane-filter technique as the testing method. Repeat the disinfection until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The disinfection is complete when satisfactory bacteriological results are obtained.

-- End of Section --

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SECTION 13930

WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION
04/98

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NOTE: This guide specification covers the requirements for wet pipe fire protection sprinkler systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

****

NOTE: This specification section is intended for performance designed systems in which sprinkler branch lines cross mains and sprinkler heads are not indicated on the contract drawings. The Contractor will lay out and size the sprinkler system branch lines, cross mains and sprinkler heads. If a complete design of the sprinkler system is to be indicated on the contract drawings, this section will require editing.

For performance designs, the contract documents must

show and size all piping and equipment from the point of connection, to the sprinkler cross mains. Contract drawings will indicate, as a minimum, the location and size of the service mains, interior feed mains, control valves, sprinkler risers, and drain lines. In addition, a sprinkler riser diagram, and location of all sectional valves, inspector's test valves and switches will be indicated. The designer must also clearly indicate or specify the extent or limits of coverage, the density requirements for specific areas, specific water supply data, the type and temperature ratings of sprinklers for specific areas, and other applicable information.

In areas requiring sprinkler protection, concealed spaces, such as spaces above suspended ceilings, will be indicated to be sprinklered if they are to contain combustible construction or combustible materials.

Designer will identify on the contract drawings areas subject to freezing and will indicate appropriate means to preclude freezing of sprinkler piping.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990; R 1995) Ferritic Malleable Iron Castings
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 135	(1997) Electric-Resistance-Welded Steel Pipe
ASTM A 183	(1983; R 1998) Carbon Steel Track Bolts and Nuts
ASTM A 536	(1984; R 1993) Ductile Iron Castings

ASTM A 795	(1997) Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM D 3309	(1996a) Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems
ASTM F 442/F 442M	(1997) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)

ASTM INTERNATIONAL (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Gray Iron Threaded Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995; B16.22a) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B18.2.1	(1996) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(1987; R 1999) Square and Hex Nuts (Inch Series)

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1015	(1993) Double Check Backflow Prevention Assembly

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA EWW	(1995) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C111	(1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C203	(1997) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825a	(1998) Approval Guide Fire Protection
FM P7825b	(1998) Approval Guide Electrical Equipment

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(1996; Errata 13-96-1) Installation of Sprinkler Systems
NFPA 13R	(1996) Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height
NFPA 24	(1995) Installation of Private Fire Service Mains and Their Appurtenances
NFPA 231C	(1998) Rack Storage of Materials
NFPA 1963	(1998) Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(1995) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

UNDERWRITERS LABORATORIES (UL)

UL 668	(1995; Rev thru Dec 1998) Hose Valves For Fire Protection Service

UL Bld Mat Dir (1998) Building Materials Directory

UL Fire Prot Dir (1998) Fire Protection Equipment Directory

1.2 GENERAL REQUIREMENTS

****

NOTE: Residential Occupancies: NFPA 13R is applicable for residential occupancies up to and including 4 stories in height. This standard should be referenced and followed only for such occupancies. NFPA 13R differs from NFPA 13 relative to type of sprinkler, design criteria, sprinkler coverage, etc. Care must be taken when using this specification for residential occupancies to assure that the final project specification clearly indicates design requirements.

****

Wet pipe sprinkler system shall be provided in [all areas of the building] [areas indicated on the drawings] [_____]. The sprinkler system shall provide fire sprinkler protection for the entire area. Except as modified herein, the system shall be designed and installed in accordance with [NFPA 13] [NFPA 13R]. Rack sprinkler shall be in accordance with NFPA 231C. Pipe sizes which are not indicated on drawings shall be determined by hydraulic calculation.

1.2.1 Hydraulic Design

****

NOTE: Applications requiring multiple densities/design areas must be referred to and shown on the drawings.

Systems covering 140 square meters (1500 square feet) or greater will be hydraulically designed. Only systems less than 140 square meters (1500 square feet) may be designed using the pipe schedule method of NFPA 13. This section must be edited if the system is to be designed using the pipe schedule method.

For sprinkler systems in residential occupancies, which are designed to NFPA 13R standards, paragraphs which address hydraulic design and sprinkler spacing must be edited according to NFPA 13R requirements.

****

The system shall be hydraulically designed to discharge a minimum density of [_____] gpm per square foot over the hydraulically most demanding [3,000] [_____] square feet of floor area. The minimum pipe size for branch lines in gridded systems shall be 1-1/4 inch. Hydraulic calculations shall be in accordance with the Area/Density Method of NFPA 13.

1.2.1.1 Hose Demand

An allowance for exterior hose streams of [_____] gpm shall be added to the sprinkler system demand [at the fire hydrant shown on the drawings closest to the point where the water service enters the building] [at the point of connection to the existing system]. [An allowance for interior hose stations of [_____] gpm shall also be added to the sprinkler system demand.]

1.2.1.2 Basis for Calculations

****

NOTE: The design must include an adequate water supply to meet the sprinkler water demand. The designer must provide water flow test results and hydraulic calculations to ensure that the system demand will be met.

Water Flow Testing: When connecting to an existing water distribution system, waterflow tests will be conducted to determine available water supply for the sprinkler system. Test results will be included as part of the concept design submission. The designer should perform the tests or witness the testing performed by others.

Design Calculations: The designer will provide detailed hydraulic calculations that clearly demonstrate that the water supply will meet the demand of the sprinkler system and hose streams. Calculations will be submitted with the concept design submission.

****

The design of the system shall be based upon a water supply with a static pressure of [_____], and a flow of [_____] at a residual pressure of [_____]. Water supply shall be presumed available [at the point of connection to existing] [at the base of the riser] [_____]. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for steel piping, 150 for copper tubing, 140 for new cement-lined ductile-iron piping, and [100] [_____] for existing underground piping.

1.2.2 Sprinkler Spacing

Sprinklers shall be uniformly spaced on branch lines. Maximum spacing per sprinkler shall not exceed [[_____] square feet.] [limits specified in NFPA 13 for [light] [ordinary] [extra] hazard occupancy.]

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. Submittals related to system configuration, hydraulic calculations, and equipment selection, including manufacturer's catalog data, working drawings, connection drawings, control diagrams and certificates shall be submitted concurrently as a complete package. The package will be reviewed by the U.S. Army Engineer District Fire Protection Engineer. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Load Calculations for Sizing Sway Bracing

For systems that are required to be protected against damage from earthquakes, load calculations shall be provided for sizing of sway bracing.

Sprinkler System Equipment; GA.

Manufacturer's Catalog Data for each separate piece of equipment proposed for use in the system. Data shall indicate the name of the manufacturer of each item of equipment, with data highlighted to indicate model, size, options, etc. proposed for installation. In addition, a complete equipment list which includes equipment description, model number and quantity shall be provided.

Hydraulic Calculations; GA.

Hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments.

Spare Parts; [_____].

Spare parts data shall be included for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. A list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor shall be included.

SD-04 Drawings

Sprinkler System Shop Drawings; GA.

Detail drawings conforming to the requirements established for working plans as prescribed in NFPA 13. Drawings shall include plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.

b. Floor plans drawn to a scale not less than 1/8" = 1'-0" which clearly show locations of sprinklers, risers, pipe hangers, seismic separation assemblies, sway bracing, inspector's test connections, drains, and other applicable details necessary to clearly describe the proposed arrangement. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be indicated.

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross-mains and branch lines to finished floor and roof or ceiling. A detail shall show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

d. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical sprinkler above finished floor.

e. Details of each type of riser assembly; pipe hanger; sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring.

As-Built Drawings; FIO.

As-built drawings, no later than 14 working days after completion of the Final Tests. The sprinkler system shop drawings shall be updated to reflect as-built conditions after work is completed and shall be on reproducible full-size mylar film.

SD-06 Instructions

Test Procedures; GA.

Proposed test procedures for piping hydrostatic test, testing of alarms, at least 14 days prior to the start of related testing.

SD-07 Schedules

Preliminary Tests; GA.

A schedule of preliminary tests, at least 14 days prior to the proposed start of the tests.

Final Test; GA.

Upon successful completion of tests specified under paragraph PRELIMINARY TESTS, written notification shall be given to the Contracting Officer of the date for the final acceptance test. Notification shall be provided at least [14] [_____] days prior to the proposed start of the test. Notification shall include a copy of the Contractor's Material & Test Certificates.

SD-08 Statements

Installer Qualifications; GA.

Qualifications of the sprinkler installer.

Submittal Preparer's Qualifications; GA.

The name and documentation of certification of the individual who will prepare the submittals, prior to the submittal of the drawings and hydraulic calculations.

SD-13 Certificates

Contractor's Material & Test Certificates; [_____].

Certificates, as specified in NFPA 13, shall be completed and signed by the Contractor's Representative performing required tests for both underground and aboveground piping.

SD-19 Operation and Maintenance Manuals

Sprinkler System; [_____].

Manuals shall be in loose-leaf binder format and grouped by technical sections consisting of manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. The manuals shall list routine maintenance procedures possible breakdowns, and repairs, and troubleshooting guide. This shall include procedures and instructions pertaining to frequency of preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair.

1.4 HYDRAULIC CALCULATIONS

Hydraulic calculations shall be as outlined in NFPA 13 except that calculations shall be performed by computer using software specifically designed for fire protection system design. Software which uses k-factors for typical branch lines is not acceptable. Calculations shall be taken back to the water supply source unless water supply data is otherwise indicated. Calculations shall substantiate that the design area indicated is the hydraulically most demanding. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. A summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows shall be provided. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. The diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient shall be indicated for each pipe. For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. Also for gridded systems, a flow diagram indicating the quantity and direction of flows shall be included. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

1.5 SUBMITTAL PREPARER'S QUALIFICATIONS

****

NOTE: Level IV may be selected where warranted by system complexity.

****

The sprinkler system submittals, including as-built drawings, shall be prepared by an individual who is either a registered professional engineer or who is certified as a Level [III] [IV] Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.6 INSTALLER QUALIFICATIONS

The installer shall be experienced and regularly engaged in the installation of the type and complexity of system included in this project. A statement prior to submittal of any other data or drawings, that the proposed sprinkler system installer is regularly engaged in the installation of the type and complexity of system included in this project shall be provided. In addition, data identifying the location of at least three systems recently installed by the proposed installer which are comparable to the system specified shall be submitted. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months.

1.7 REGULATORY REQUIREMENTS

Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. Applicable material and installation standards referenced in Appendix A of NFPA 13 and NFPA 24 shall be considered mandatory the same as if such referenced standards were specifically listed in this specification. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification shall govern. All requirements that exceed the minimum requirements of NFPA 13 shall be incorporated into the design. Reference to "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

1.8 DELIVERY AND STORAGE

Equipment placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust or other contaminants.

PART 2 PRODUCTS

2.1 GENERAL EQUIPMENT REQUIREMENTS

2.1.1 Standard Products

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.1.2 Requirements for Fire Protection Service

Equipment and materials shall have been tested by Underwriters Laboratories, Inc. and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM P7825a and FM P7825b. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire

Prot Dir or FM P7825a and FM P7825b

2.1.3 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate permanently affixed to the item of equipment.

2.2 UNDERGROUND PIPING SYSTEMS

****
NOTE: The drawings must show the service connection details and the underground water mains for the sprinkler system. The drawings must show details of the water service point-of-entry into the building and through the floor slab, and underground piping restraints, including number and size of restraining rods and thrust blocks.
****

2.2.1 Pipe

Piping from a point 6 inches above the floor to [a point 5 feet outside the building wall] [the point of connection to the existing water mains] shall be ductile iron with a rated working pressure of [150] [175] [_____] psi conforming to AWWA C151, with cement mortar lining conforming to AWWA C104. Piping more than 5 feet outside the building walls shall comply with Section 02510 WATER DISTRIBUTION SYSTEM.

2.2.2 Fittings and Gaskets

Fittings shall be ductile iron conforming to AWWA C110. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111.

2.2.3 Gate Valve and Indicator Posts

****
NOTE: This paragraph will be deleted if underground valves are either not required or are specified elsewhere.
****

Gate valves for underground installation shall be of the inside screw type with counter-clockwise rotation to open. Where indicating type valves are shown or required, indicating valves shall be gate valves with an approved indicator post of a length to permit the top of the post to be located 3 feet above finished grade. Gate valves and indicator posts shall be listed in UL Fire Prot Dir or FM P7825a and FM P7825b.

2.3 ABOVEGROUND PIPING SYSTEMS

****
NOTE: The following are basic restrictions on the use of plastic pipes:

a. Plastic pipe is permitted only in light hazard

occupancies and in residential occupancies.

b. Plastic piping is not allowed in combustible concealed spaces which are required to be sprinklered.

c. Plastic piping is not allowed in spaces where ambient temperature exceed 65 Degrees C (150 Degrees F) for CPVC piping and 48 Degrees C (120 Degrees F) for PB piping.

d. Plastic piping must be protected, as a minimum, by either (1) one layer of 9.525 mm (3/8 inch) thick gypsumboard, or (2) a suspended membrane ceiling with lay-in ceiling panels or tiles having a weight of not less than 1.7 kilogram per square meter (0.35 psf) installed on metallic support grids, or by other method approved by UL. Method or protection of piping must be indicated and detailed in the contract documents.

e. Plastic pipe must not be provided where water pressure surges could exceed 1207 kPa (175 psi).

f. Plastic piping must not be provided in areas where the system could be subject to impact or physical stress or abuse.

g. Plastic piping can only be used in wet pipe sprinkler systems.

h. Quick response sprinkler heads should be provided.

****

Aboveground piping shall be steel [or copper] [, copper, or plastic].

2.3.1   Steel Piping System

****

NOTE: Specify steel piping exposed to the weather or corrosive atmospheres to be galvanized or properly protected against corrosive effects.

****

2.3.1.1   Steel Pipe

Except as modified herein, steel pipe shall be [black] [galvanized] [galvanized where indicated] as permitted by NFPA 13 and shall conform to applicable provisions of ASTM A 795, ASTM A 53, or ASTM A 135. Pipe in which threads or grooves are cut shall be Schedule 40 or shall be listed by Underwriters' Laboratories to have a corrosion resistance ratio (CRR) of 1.0 or greater after threads or grooves are cut. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

2.3.1.2   Fittings for Non-Grooved Steel Pipe

Fittings shall be cast iron conforming to ASME B16.4, steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. [Steel press fittings shall be approved for fire protection systems.] [Galvanized fittings shall be used for piping systems or portions of piping systems utilizing galvanized piping.] Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings which use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

2.3.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 175 psi service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated.

2.3.1.4 Flanges

Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thick, and full face or self-centering flat ring type. Bolts shall be squarehead conforming to ASME B18.2.1 and nuts shall be hexagon type conforming to ASME B18.2.2.

2.3.2 Copper Tube Systems

2.3.2.1 Copper Tube

Copper tube shall conform to ASTM B 88, Types L and M.

2.3.2.2 Copper Fittings

Cast copper alloy pressure fittings shall conform to ASME B16.18 and wrought copper and bronze pressure fittings shall conform to ASME B16.22.

2.3.3 Plastic Pipe Systems

****

NOTE: When plastic pipe is not permitted, delete this paragraph.

****

2.3.3.1 Plastic Pipe

Plastic pipe shall be listed in UL Fire Prot Dir for use in wet pipe sprinkler systems and shall conform to requirements as follows:

a. Chlorinated Polyvinyl Chloride (CPVC): ASTM F 442/F 442M, 175 psi rating.

b. Polybutylene (PB): ASTM D 3309, 175 psirating.

2.3.3.2 Plastic Fittings

Plastic fitting shall be chlorinated polyvinyl chloride (CPVC) or polybutylene (PB) as listed in UL Fire Prot Dir for use in wet pipe sprinkler systems.

2.3.4 Pipe Hangers

Hangers shall be listed in UL Fire Prot Dir or FM P7825a and FM P7825b and of the type suitable for the application, construction, and pipe type and sized involved.

2.3.5 Valves

2.3.5.1 Control Valve and Gate Valve

****

NOTE: A control valve is required for control of each individual sprinkler riser. The type of such valves should be either the OS&Y or wall type indicator post. Where multiple risers are supplied from a single water service, riser control valves of the OS&Y type should be located in a valve room with exterior access. For more guidance on arrangement of sprinkler control valves, refer to NFPA 13, Appendix A.

****

Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) type and shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b.

2.3.5.2 Check Valve

Check valve 2 inches and larger shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b. Check valves 4 inchesand larger shall be of the swing type with flanged cast iron body and flanged inspection plates, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

2.3.5.3 Hose Valve

****

NOTE: This specification does not include standpipe systems covered by NFPA 14. However, in conjunction with the project drawings, this specification can be expanded to include combined sprinkler and standpipe systems. Delete hose valve reducer when not required.

****

Valve shall comply with UL 668 and shall have a minimum rating of 300 psi. Valve shall be non-rising stem, all bronze, 90 degree angle type, with 2-1/2 inch American National Standard Fire Hose Screw Thread (NH) male outlet in accordance with NFPA 1963. Hose valve shall be provided with 2-1/2 to 1-1/2 inch reducer. Hose valves shall be equipped with lugged cap with drip drain, cap gasket and chain. Valve finish shall be [polished brass] [rough chrome plated] [polished chrome plated].

2.4 ALARM CHECK VALVE ASSEMBLY

Assembly shall include an alarm check valve, standard trim piping, pressure gauges, bypass, retarding chamber, testing valves, main drain, and other components as required for a fully operational system.

2.5 WATER MOTOR ALARM ASSEMBLY

Assembly shall include a body housing, impeller or pelton wheel, drive shaft, striker assembly, gong, wall plate and related components necessary for complete operation. Minimum 3/4 inch galvanized piping shall be provided between the housing and the alarm check valve. Drain piping from the body housing shall be minimum 1 inch galvanized and shall be arranged to drain to the outside of the building. Piping shall be galvanized both on the inside and outside surfaces.

2.6 ALARM INITIATING AND SUPERVISORY DEVICES

****

NOTE: Water motor alarms and pressure alarm switches can be used only with an alarm check valve. Vane type waterflow indicators can be used with or without an alarm check valve and are often used for zoning of the system, e.g., building wings or floors.

To permit testing of each alarm device, the designer will indicate a separate inspector's test connection for each device. Coordinate selections and delete inapplicable devices.

****

2.6.1 Sprinkler Waterflow Indicator Switch, Vane Type

Switch shall be vane type with a pipe saddle and cast aluminum housing. The electro-mechanical device shall include a flexible, low-density polyethylene paddle conforming to the inside diameter of the fire protection pipe. The device shall sense water movements and be capable of detecting a sustained flow of 10 gpm or greater. The device shall contain a retard device adjustable from 0 to 90 seconds to reduce the possibility of false alarms caused by transient flow surges. The switch shall include two SPDT (Form C) contacts, and shall be equipped with a silicone rubber gasket to assure positive water seal and a dustproof cover and gasket to seal the mechanism from dirt and moisture.

2.6.2 Sprinkler Pressure (Waterflow) Alarm Switch

Pressure switch shall include a metal housing with a neoprene diaphragm, SPDT snap action switches and a 1/2 inch NPT male pipe thread. The switch shall have a maximum service pressure rating of 175 psi. There shall be two SPDT (Form C) contacts factory adjusted to operate at 4 to 8 psi. The switch shall be capable of being mounted in any position in the alarm line trim piping of the alarm check valve.

2.6.3 Valve Supervisory (Tamper) Switch

Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

2.7 FIRE DEPARTMENT CONNECTION

****

NOTE: Designer will verify type of threads used by the fire department serving the building where the sprinkler system is being installed.

****

Fire department connection shall be [projecting] [flush] type with cast brass body, matching wall escutcheon lettered "Auto Spkr" with a [polished brass] [chromium plated] finish. The connection shall have two inlets with individual self-closing clappers, caps with drip drains and chains. Female inlets shall have 2-1/2 inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963.

2.8 SPRINKLERS

****

NOTE: Delete quick response sprinklers when not required.

Designer will indicate on the contract drawings the type of sprinkler heads for each area.

Areas that are classified as light hazard will be equipped with quick response sprinklers. Residential areas will be equipped with residential sprinklers.

****

Sprinklers shall be used in accordance with their listed spacing limitations. Temperature classification shall be [ordinary] [intermediate] [_____] [as indicated]. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters shall have temperature classification in accordance with NFPA 13. Sprinklers with internal O-rings shall not be used.

2.8.1 Upright Sprinkler

Upright sprinkler shall be [brass] [chrome-plated] [white enamel] [quick-response type] [_____] and shall have a nominal 1/2 inch or 17/32 inch orifice.

2.8.2 Pendent Sprinkler

Pendent sprinkler shall be of the fusible strut or glass bulb type, [recessed] [quick-response] type with nominal 1/2 inch [or 17/32 inch] orifice. Pendent sprinklers shall have a [polished chrome] [or] [white enamel] [_____] finish.

2.8.3 Sidewall Sprinkler

Sidewall sprinkler shall have a nominal 1/2 inchorifice. Sidewall sprinkler shall have a [brass] [polished chrome] [white enamel] [_____] finish. Sidewall sprinkler shall be the quick-response type.

2.8.4   Residential Sprinkler

Residential sprinkler shall be the [pendent] [and] [sidewall] type with nominal 1/2 inch orifice. Residential sprinkler shall have a [polished chrome] [white enamel] [_____] finish.

2.8.5   Intermediate Level Rack Sprinkler

Intermediate level rack sprinkler shall be of the upright or pendent type with nominal 1/2 inch orifice and minimum "K" factor of 5.5. The sprinkler shall be equipped with a deflector plate to shield the fusible element from water discharged above it.

2.8.6   Dry Sprinkler Assembly

Dry sprinkler assembly shall be of the [pendent,] [upright,] [sidewall,] [45-degree] type as indicated. Assembly shall include an integral escutcheon. Maximum length shall not exceed maximum indicated in UL Fire Prot Dir. Sprinklers shall have a [polished chrome] [or] [white enamel] finish.

2.8.7   Corrosion Resistant Sprinkler

****

NOTE: The use of corrosion resistant sprinklers is generally limited to industrial type occupancies such as those involving electroplating, steam rooms, salt storage, and piers and wharves.

****

Corrosion resistant sprinkler shall be the [upright] [pendent] type installed in locations as indicated. Corrosion resistant coatings shall be factory-applied by the sprinkler manufacturer.

2.9   DISINFECTING MATERIALS

2.9.1   Liquid Chlorine

Liquid chlorine shall conform to AWWA B301.

2.9.2   Hypochlorites

Calcium hypochlorite and sodium hypochlorite shall conform to AWWA B300.

2.10   ACCESSORIES

2.10.1   Sprinkler Cabinet

Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required shall be provided.

2.10.2   Pendent Sprinkler Escutcheon

Escutcheon shall be one-piece metallic type with a depth of less than 3/4 inch and suitable for installation on pendent sprinklers. The escutcheon shall have a factory finish that matches the pendent sprinkler heads.

2.10.3 Pipe Escutcheon

Escutcheon shall be polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set screw.

2.10.4 Sprinkler Guard

Guard shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers located [_____] [as indicated].

2.10.5 Identification Sign

Valve identification sign shall be minimum 6 inches wide x 2 inches high with enamel baked finish on minimum 18 gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary drain," "inspector's test," "alarm test," "alarm line," and similar wording as required to identify operational components.

2.11 FIRE HOSE REEL ASSEMBLY

Assembly shall include nozzle, fire hose, reel, 1-1/2 inch valve, and bracket suitable for wall mounting. The assembly shall be semi-automatic type complete with Underwriters clip which permits controlled one-man operation whereby control valve can be opened, hose unreeled and clip released by pulling on hose. Valve shall be non-rising stem, all bronze, angle type with 1-1/2 inch American National Standard Fire Hose Screw Thread (NH) male outlet in accordance with NFPA 1963. Reel shall be of steel construction with red enamel finish and shall be equipped with 100 feet of 1-1/2 inch rubber lined fire hose. Nozzle shall be of the industrial combination fog-straight stream type with shutoff. Components of the assembly shall be listed in UL Fire Prot Dir.

2.12 DOUBLE-CHECK VALVE BACKFLOW PREVENTION ASSEMBLY

Double-check backflow prevention assembly shall comply with ASSE 1015. The assembly shall have a bronze, cast-iron or stainless steel body with flanged ends. The assembly shall include OS&Y shutoff valves on the inlet and outlet, 2-positive-seating check valve for continuous pressure application, and four test cocks. Assemblies shall be rated for working pressure of [150] [175] [_____] psi. The maximum pressure loss shall be 6 psi at a flow rate equal to the sprinkler water demand, at the location of the assembly.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein. Installation of in-rack sprinklers shall comply with applicable provisions of NFPA 231C.

3.2 ABOVEGROUND PIPING INSTALLATION

Piping shall be run straight and bear evenly on hangers and supports.

3.2.1   Protection of Piping Against Earthquake Damage

****
NOTE: Sprinkler piping is required to be seismically protected except for those systems which are in buildings located in areas with an effective peak velocity-related acceleration (Av) of 0.10 or less. The designer shall indicate location of all building seismic separation joints. Delete this paragraph if the sprinkler system is not required to be protected against damage from earthquake. Coordinate with structural engineer.
****

The system piping shall be protected against damage from earthquakes. Seismic protection shall include flexible couplings, sway bracing, seismic separation assemblies where piping crosses building seismic separation joints, and other features as required by NFPA 13 for protection of piping against damage from earthquakes. Branch lines shall be equipped with sway braces at the end sprinkler head and at intervals not exceeding 30 ft

3.2.2   Piping in Exposed Areas

Exposed piping shall be installed so as not to diminish exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

3.2.3   Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping shall be concealed above ceilings. Piping shall be inspected, tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas shall be concealed.

3.2.4   Pendent Sprinklers

Drop nipples to pendent sprinklers shall consist of minimum 1 inch pipe with a reducing coupling into which the sprinkler shall be threaded. Hangers shall be provided on arm-overs to drop nipples supplying pendent sprinklers when the arm-over exceeds 12 inches. Where sprinklers are installed below suspended or dropped ceilings, drop nipples shall be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling shall not extend more than 1 inch below the underside of the ceiling. On pendent sprinklers installed below suspended or dropped ceilings, the distance from the sprinkler deflector to the underside of the ceiling shall not exceed 4 inches. Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer's listed range and shall be of uniform depth throughout the finished area.

3.2.4.1   Pendent Sprinkler Locations

Pendent sprinklers in suspended ceilings shall be a minimum of 6 inches from ceiling grid.

3.2.5   Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

3.2.6 Pipe Joints

Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings and fittings shall be from the same manufacturer.

3.2.7 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2 inch.

3.2.8 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes pass through fire walls, fire partitions, or floors, a fire seal shall be placed between the pipe and sleeve in accordance with Section 07840 FIRESTOPPING. In penetrations which are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement which will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

3.2.9 Escutcheons

Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

3.2.10 Inspector's Test Connection

****

NOTE: Designer will indicate location of the inspector's test connections and valving on the contract drawings, and will provide details of drain piping, if drain piping is needed.

****

Unless otherwise indicated, test connection shall consist of 1 inch pipe connected to the remote branch line; a test valve located approximately 7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test." The discharge orifice shall be located outside the building wall directed so as not to cause damage to adjacent construction or landscaping during full flow discharge.

3.2.11 Drains

Main drain piping shall be provided to discharge [at a safe point outside the building] [at the location indicated]. Auxiliary drains shall be provided as required by NFPA 13 except that drain valves shall be used where drain plugs are otherwise permitted. Where branch lines terminate at low points and form trapped sections, such branch lines shall be manifolded to a common drain line.

3.2.12 Installation of Fire Department Connection

Connection shall be mounted [on the exterior wall approximately 3 feet above finished grade] [as shown]. The piping between the connection and the check valve shall be provided with an automatic drip in accordance with NFPA 13 and arranged to drain to the outside.

3.2.13 Identification Signs

Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13.

3.3 UNDERGROUND PIPING INSTALLATION

****

NOTE: Restraint of the underground piping must be detailed on the drawings.

****

The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be [3] [_____] feet. The supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 6 inches above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor. In addition, joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe. Buried steel components shall be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls shall meet the requirements of Section 02510 WATER DISTRIBUTION SYSTEM.

3.4 EARTHWORK

Earthwork shall be performed in accordance with applicable provisions of

Section 02315 EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS.

3.5 ELECTRICAL WORK

****
NOTE: Coordinate wiring with the drawings and other specification sections.
****

[Alarm signal wiring connected to the building fire alarm control system shall be in accordance with Section 13850 FIRE DETECTION AND ALARM SYSTEM.DIRECT CURRENT LOOP and 13851FIRE DETECTION AND ALARM SYSTEM,ADDRESSABLE.] [All wiring for supervisory and alarm circuits shall be [#14] [#16] AWG solid copper installed in metallic tubing or conduit.] Wiring color code shall remain uniform throughout the system.

3.6 DISINFECTION

****
NOTE: For modification of existing systems, provide specific procedures for disinfection of new equipment. If sprinkler piping is isolated from the domestic water piping systems by means of a reduced pressure backflow prevention assembly or if sprinkler piping in not connected to the domestic water piping, this paragraph should be deleted.
****

After all system components are installed and hydrostatic test are successfully completed, each portion of the sprinkler system to be disinfected shall be thoroughly flushed with potable water until all entrained dirt and other foreign materials have been removed before introducing chlorinating material. Flushing shall be conducted by removing the flushing fitting of the cross mains and of the grid branch lines, and then back-flushing through the sprinkler main drains. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the sprinkler piping at a constant rate of 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or liquid chlorine injected into the system through a solution-fed chlorinator and booster pump shall be used. Chlorination application shall continue until the entire system if filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system shall be opened and closed several times to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. The system shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. Samples of water in properly disinfected containers for bacterial examination will be taken from several system locations which are approved by the Contracting Officer. Samples shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method shall be either the multiple-tube fermentation technique or the membrane-filter technique. The disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.7 COLOR CODE MARKING, FIELD PAINTING AND FINISHING

****
NOTE: Designer will coordinate color code marking with Section 09900. Color code marking for piping not listed in Table I of Section 09900 will be added to the table.
****

Color code marking of piping,field painting and finishing shall be as specified in Section 09900 PAINTING, GENERAL.

3.8 PRELIMINARY TESTS

The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure shall be tested in accordance with NFPA 13 and NFPA 24. Upon completion of specified tests, the Contractor shall complete certificates as specified in paragraph SUBMITTALS.

3.8.1 Underground Piping

3.8.1.1 Flushing

Underground piping shall be flushed in accordance with NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less that the calculated maximum water demand rate of the system.

3.8.1.2 Hydrostatic Testing

New underground piping shall be hydrostatically tested in accordance with NFPA 24. The allowable leakage shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 2 quarts per hour per 100 gaskets or joints, regardless of pipe diameter.

3.8.2 Aboveground Piping

3.8.2.1 Hydrostatic Testing

Aboveground piping shall be hydrostatically tested in accordance with NFPA 13 at not less than 200 psi or 50 psi in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

3.8.3 Testing of Alarm Devices

Each alarm switch shall be tested by flowing water through the inspector's test connection. Each water-operated alarm devices shall be tested to verify proper operation.

3.8.4 Main Drain Flow Test

Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

3.9   FINAL ACCEPTANCE TEST

A technician employed by the installing Contractor shall be present for the final tests and shall provide a complete demonstration of the operation of the system. This shall include operation of control valves and flowing of inspector's test connections to verify operation of associated waterflow alarm switches. After operation of control valves has been completed, the main drain test shall be repeated to assure that control valves are in the open position. In addition, the representative shall have available copies of as-built drawings and certificates of tests previously conducted. The installation shall not be considered accepted until identified discrepancies have been corrected and test documentation is properly completed and received.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-13935 (April 1998)**
U.S. ARMY CORPS OF ENGINEERS **-----------------------**
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SECTION 13935

DRY PIPE SPRINKLER SYSTEM, FIRE PROTECTION
04/98

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NOTE: This guide specification covers the requirements for dry pipe fire protection sprinkler systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

****

NOTE: Because dry systems are slower in operation, are less reliable, and require considerable and critical maintenance, they should be limited in application and used only in areas subject to freezing. Areas which are not subject to freezing should be protected with wet pipe sprinkler systems.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in

project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990; R 1995) Ferritic Malleable Iron Castings
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 135	(1997) Electric-Resistance-Welded Steel Pipe
ASTM A 183	(1983; R 1998) Carbon Steel Track Bolts and Nuts
ASTM A 536``	(1984; R 1993) Ductile Iron Castings
ASTM A 795	(1997) Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use

ASME INTERNATIONAL (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Cast Iron Threaded Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B18.2.1	(1996) Square and Hex Bolts and Screws Inch Series
ASME B18.2.2	(1987; R 1999) Square and Hex Nuts (Inch Series)

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1015	(1993) Double Check Backflow Prevention Assembly

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA EWW	(1995) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C111	(1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C203	(1997) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825a	(1998) Approval Guide Fire Protection
FM P7825b	(1998) Approval Guide Electrical Equipment

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(1996; Errata 13-96-1) Installation of Sprinkler Systems
NFPA 24	(1995) Installation of Private Fire Service Mains and Their Appurtenances
NFPA 1963	(1998) Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(1995) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler

System Layout

UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir (1998) Building Materials Directory

UL Fire Prot Dir (1998) Fire Protection Equipment Directory

1.2 GENERAL REQUIREMENTS

****

NOTE: This section is intended for performance designed systems in which the sprinkler branch lines, cross mains and the sprinkler heads are not indicated on the contract drawings. The Contractor will lay out and size the sprinkler system branch lines, cross mains and sprinkler heads. If a complete design of the sprinkler system is to be indicated on the contract drawings, this section will require editing.

For performance designs, the contract documents must show and size all piping and equipment from the point of connection, to the sprinkler cross mains. The contract drawings will indicate as a minimum, the location and size of the service mains, interior feed mains, control valves, sprinkler risers, and drain lines. In addition, a sprinkler riser diagram, and location of all sectional valves, inspector's test valves, air compressor and switches will be indicated. The designer must also clearly indicate or specify the extent or limits of coverage, the density requirements for specific areas, specific water supply data, the type and temperature ratings of sprinklers for specific areas, and other applicable information.

****

Dry pipe sprinkler system shall be provided in [all areas of the building] [areas indicated on the drawings] [_____]. The sprinkler system shall provide fire sprinkler protection for the entire area. Except as modified herein, the system shall meet the requirements of NFPA 13. Gridded dry pipe systems are not permitted. Pipe sizes which are not indicated on the drawings shall be determined by hydraulic calculation.

1.2.1 Hydraulic Design

****

NOTE: Systems covering 140 square meters (1500 square feet) or greater will be hydraulically designed. Only systems less than 140 square meters (1500 square feet) may be designed using the pipe schedule method of NFPA 13. This section must be edited if the system is to be designed using the pipe schedule method.

****

The system shall be hydraulically designed to discharge a minimum density of [_____] gpm per square foot over the hydraulically most demanding [3,900] [_____] square feet of floor area. Hydraulic calculations shall be provided in accordance with the Area\Density Method of NFPA 13.

1.2.1.1 Hose Demand

An allowance for exterior hose streams of [_____] gpm shall be added to the sprinkler system demand [at the fire hydrant shown on the drawings closest to the point where the water service enters the building.] [at the point of connection to the existing water system.]

1.2.1.2 Basis for Calculations

****

NOTE: The design must include an adequate water supply to meet the sprinkler water demand. The designer must provide water flow test results and hydraulic calculations to ensure that the system demand will be met.

Water Flow Testing: When connecting to an existing water distribution system, waterflow tests will be conducted to determine available water supply for the sprinkler system. Test results will be included as part of the concept design submission. The designer should perform the tests or witness the testing performed by others.

Design Calculations: The designer will provide detailed hydraulic calculations that clearly demonstrate that the water supply will meet the demand of the sprinkler system and hose streams. Calculations will be submitted with the concept design submission.

****

The design of the system shall be based upon a water supply with a static pressure of [_____] psig, and a flow of [_____] gpm at a residual pressure of [_____] psig. Water supply shall be presumed available [at the base of the riser] [at the point of connection to the existing piping] [_____]. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for galvanized steel piping, 140 for new cement-lined ductile-iron piping, and [100] [_____] for existing underground piping.

1.2.2 Sprinkler Spacing

Sprinklers shall be uniformly spaced on branch lines. Maximum spacing per sprinkler shall not exceed [[_____] square feet.] [limits specified in NFPA 13 for [light] [ordinary] [extra] hazard occupancy.]

1.2.3 System Volume Limitations

****

NOTE: Designer must ensure by calculation that a

sufficient number of systems is provided to limit piping volume to less than 2800 liters (750 gallons).
****

When a system piping volume exceeds 500 gallons the dry pipe valve shall be provided with a quick-opening device. The maximum system capacity controlled by one dry pipe valve shall not exceed 750 gallons.

1.3   SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. Submittals related to system configuration, hydraulic calculations, and equipment selection, including manufacturer's catalog data, working drawings, connection drawings, control diagrams and certificates shall be submitted concurrently as a complete package. The package will be reviewed by the U.S. Army Engineer District Fire Protection Engineer. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Load Calculations for Sizing Sway Bracing

For systems that are required to be protected against damage from earthquakes, load calculations for sizing of sway bracing.

Genral Equipment Requirements; GA.

Manufacturer's Catalog Data for each separate piece of equipment proposed for use in the system. Data shall indicate the name of the manufacturer of each item of equipment, with data highlighted to indicate model, size, options, etc. proposed for installation. In addition, a complete equipment list which includes equipment description, model number and quantity shall be provided.

Hydraulic Calculations; GA.

Hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments.

Spare Parts; [_____].

Spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. A list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor shall be included.

SD-04 Drawings

Sprinkler System Shop Drawings; GA.

Detailed drawings conforming to the requirements established for working plans as prescribed in NFPA 13. Drawings shall include plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.

b. Floor plans drawn to a scale not less than 1/8"= 1'-0" which clearly show locations of sprinklers, risers, pipe hangers, seismic separation assemblies, sway bracing, inspector's test connections, drains, and other applicable details necessary to clearly describe the proposed arrangement. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be indicated.

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross-mains and branch lines to finished floor and roof or ceiling. A detail shall show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

d. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical sprinkler above finished floor.

e. Details of each type of riser assembly; air supply system and piping; pipe hanger; sway bracing for earthquake protection; restraint of underground water main at point-of-entry into the building; and electrical devices and interconnecting wiring.

As-Built Drawings; FIO.

As-built drawings, no later than [14] [_____] working days after completion of the Final Tests. The sprinkler system shop drawings shall be updated to reflect as-built conditions after work is completed and shall be submitted on reproducible full-size mylar film.

SD-06 Instructions

Test Procedures; GA.

Proposed test procedures for piping hydrostatic test, trip-tests of dry pipe valve and alarm test, at least 14 days prior to the start of related testing.

SD-07 Schedules

Preliminary Tests; GA.

A schedule of preliminary tests, at least 14 days prior to the proposed start of tests.

Final Test; GA.

Upon successful completion of tests specified in paragraph PRELIMINARY TESTS, written notification shall be given to the Contracting Officer of the date for the final acceptance test. Notification shall be provided at least [14] [_____] days prior to the proposed start of the final test. Notification shall include a copy of the Contractor's Material & Test Certificates.

SD-08 Statements

Installer Qualifications; GA.

Qualifications of the sprinkler installer.

Submittal Preparer's Qualifications; GA.

The name and documentation of certification of the individual who will prepare the submittals, prior to the submittal of the drawings and hydraulic calculations.

SD-13 Certificates

Contractor's Material & Test Certificates; GA.

Certificates, as specified in NFPA 13, completed and signed by the Contractor's Representative performing required tests for both underground and aboveground piping.

SD-19 Operation and Maintenance Manuals

Sprinkler System; [_____].

Manuals in loose-leaf binder format and grouped by technical sections consisting of manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. The manuals shall list routine maintenance procedures, possible breakdowns, and repairs, and troubleshooting guide. This shall include procedures and instructions pertaining to frequency of preventive maintenance, inspection, testing; adjustment, lubrication and cleaning of the entire system as necessary to minimize corrective maintenance and repair.

1.4   HYDRAULIC CALCULATIONS

Hydraulic calculations shall be as outlined in NFPA 13 except that calculations shall be performed by computer using software specifically designed for fire protection system design. Software which uses k-factors for typical branch lines is not acceptable. Calculations shall be taken back to the water supply source or to the point where flow test data was measured. Calculations shall substantiate that the design area indicated is the hydraulically most demanding. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculations. A summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows shall be provided. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. The diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient shall be indicated for each pipe. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings. Calculations determining the volume capacity of the dry pipe system shall be provided.

1.5 SUBMITTAL PREPARER'S QUALIFICATIONS

The sprinkler system submittals, including as-built drawings, shall be prepared by an individual who is either a registered professional engineer or who is certified as a Level [III] [IV] Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.6 INSTALLER QUALIFICATIONS

The installer shall be experienced and regularly engaged in the installation of the type and complexity of system included in this project. A statement prior to submittal of any other data or drawings, that the proposed sprinkler system installer is regularly engaged in the installation of the type and complexity of system included in this project shall be provided. In addition, data identifying the location of at least 3 systems recently installed by the proposed installer which are comparable to the system specified shall be submitted. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months.

1.7 REGULATORY REQUIREMENTS

Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. Applicable material and installation standards referenced in Appendix A of NFPA 13 and NFPA 24 shall be considered mandatory the same as if such referenced standards were specifically listed in this specification. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification shall govern. All requirements that exceed the minimum requirements of NFPA 13 shall be incorporated into the design. Reference to "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

1.8 DELIVERY AND STORAGE

Equipment placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust or other contaminants.

PART 2 PRODUCTS

2.1 GENERAL EQUIPMENT REQUIREMENTS

2.1.1 Standard Products

Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.1.2 Requirements for Fire Protection Service

Unless otherwise specified, equipment and materials shall have been tested by Underwriters Laboratories, Inc. and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM P7825a and FM P7825b. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM P7825a and FM P7825b.

2.1.3 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, voltage and current rating and catalog number on a metal plate permanently affixed to the equipment.

2.2 UNDERGROUND PIPING SYSTEMS

****

NOTE: The drawings must show the service connection details and the underground water mains for the sprinkler system. The drawings must show details of the water service point-of-entry into the building and through the floor slab, and underground piping restraints, including number and size of restraining rods and thrust blocks.

****

2.2.1 Pipe

Piping from a point 6 inches above the floor to [a point 5 feet outside the building wall] [the point of connection to the existing water mains] shall be ductile iron with a rated working pressure of [150] [175] [_____] psi conforming to AWWA C151, with cement mortar lining conforming to AWWA C104. Piping more than 5 feetoutside the building walls shall comply with Section 02510 WATER DISTRIBUTION SYSTEM.

2.2.2 Fittings and Gaskets

Fittings shall be ductile iron conforming to AWWA C110. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111.

2.2.3 Gate Valve and Indicator Post

****

NOTE: Delete this paragraph if underground valves are not required or are specified elsewhere.

****

Gate valve for underground installation shall be of the inside screw type with counter-clockwise rotation to open. Where indicating type valves are shown or required, indicating valve shall be gate valve with an approved indicator post of a length to permit the top of the post to be located 3 feet above finished grade. Gate valves and indicator posts shall be listed in UL Fire Prot Dir or FM P7825a and FM P7825b.

2.3 ABOVEGROUND PIPING SYSTEMS

2.3.1 Piping Systems

Sprinkler piping shall be steel galvanized piping. The inside wall and the exterior of the pipe shall be galvanized. Steel piping shall be Schedule [40] [40 or Schedule 10] for sizes less than 8 inches in diameter and Schedule 30 or 40 for sizes 8 inches and larger in diameter. Piping shall conform to applicable provisions of ASTM A 795, ASTM A 53, or ASTM A 135. Pipe in which threads or grooves are cut shall be Schedule 40 or shall be listed by Underwriters Laboratories to have a corrosion resistance ratio (CRR) of 1.0 or greater after threads or grooves are cut. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

2.3.2 Fittings For Non-Grooved Piping

Fittings shall be cast iron conforming to ASME B16.4, galvanized steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings which use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

2.3.3 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 175 psi service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12. Gaskets shall be of silicon compound and approved for dry fire protection systems. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated.

2.3.4 Flanges

Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thick, and full face or self-centering flat ring type. Bolts shall be square-head conforming to ASME B18.2.1 and nuts shall be hexagon type conforming to ASME B18.2.2.

2.3.5 Pipe Hangers

Hangers shall be listed in UL Fire Prot Dir or FM P7825a and FM P7825b and be of the type suitable for the application, construction, and size pipe involved.

2.3.6 Valves

2.3.6.1 Control Valve and Gate Valve

****

NOTE: A control valve is required for control of each individual sprinkler riser. Where multiple

risers are supplied from a single water service, riser control valves of the OS&Y type should be located in a valve room with exterior access. For guidance on suggested locations of sprinkler control valves, refer to NFPA 13, Appendix A.
****

Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) gate valves and shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b.

2.3.6.2 Check Valve

Check valve 2 inches and larger shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b. Check valve 4 inches and larger shall be of the swing type with flanged cast iron body and flanged inspection plate, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

2.4 DRY PIPE VALVE ASSEMBLY

****
NOTE: If sprinkler system air capacity does not require the provision of a quick opening device, delete the last sentence.
****

The dry pipe valve shall be a latching differential type listed in UL Fire Prot Dir or FM P7825a and FM P7825b and shall be complete with trim piping, valves, fittings, pressure gauges, priming water fill cup, velocity drip check, drip cup, and other ancillary components as required for proper operation. The assembly shall include a quick-opening device by the same manufacturer as the dry pipe valve for systems over 500 gallons in capacity.

2.5 AIR SUPPLY SYSTEM

****
NOTE: Drawings must indicate a connection to a reliable power source for the compressor and the low air pressure alarm device.
****

Air supply system shall be in accordance with NFPA 13. The connection pipe from the air compressor shall not be less than 1/2 inch in diameter and shall enter the system above the priming water level of the dry pipe valve. A check valve shall be installed in the air line piping and a shutoff valve of the renewable disc type shall be installed on the supply side of this check valve. The air supply system shall be sized to pressurize the sprinkler system to [40] [_____] psi within 20 minutes.

2.5.1 Air Compressor

Compressor shall be single stage oilless type, air cooled, electric-motor driven, equipped with a check valve, shutoff valve and pressure switch for automatic starting and stopping. Pressure switch shall be factory set to start the compressor at [30] [_____] psi and stop it at [40] [_____] psi. A safety relief valve, set to operate at [65] [_____] psi, shall be provided.

2.5.2 Air Pressure Maintenance Device

Device shall be a pressure regulator which automatically reduces supply air pressure to pressure required to be maintained in the piping system. The device shall have a cast bronze body and valve housing complete with diaphragm assembly, spring, filter, ball check to prevent backflow, 1/16 inch restriction to prevent rapid pressurization of the system, and adjustment screw. The device shall be capable of reducing an inlet pressure of up to 100 psig to a fixed outlet pressure adjustable to 10 psig.

2.5.3 Air Supply Piping System

****
NOTE: Delete air compressor when not required.
****

System shall be configured so that each dry pipe system is equipped with a separate pressure maintenance device, air compressor, shutoff valve, bypass valve and pressure gauge. Piping shall be galvanized steel in accordance with ASTM A 795 or ASTM A 53.

2.5.4 Low Air Pressure Alarm Device

Each dry pipe valve trim shall be provided with a local alarm device consisting of a metal enclosure containing an alarm horn or bell, silence switch, green power-on light, red low-air alarm light and amber trouble light. The alarm device shall be activated by the low air pressure switch. Upon reduction of sprinkler system pressure to approximately 10 psig above the dry valve trip point pressure, the low air pressure switch shall actuate the audible alarm device and a red low-air alarm light. Restoration of system pressure shall cause the low-air alarm light to be extinguished and the audible alarm to be silenced. An alarm silence switch shall be provided to silence the audible alarm. An amber trouble light shall be provided which will illuminate upon operation of the silence switch and shall be extinguished upon return to its normal position.

2.6 WATER MOTOR ALARM ASSEMBLY

Assembly shall include a body housing, impeller wheel, drive shaft, striker assembly, gong, wall plate and related components necessary for complete operation. Minimum 3/4 inch galvanized piping shall be provided between the housing and the alarm check valve. Drain piping from the body housing shall be minimum 1 inch galvanized steel and shall be arranged to drain to the outside of the building. Piping shall be galvanized both on the inside and on the outside surfaces.

2.7 FIRE DEPARTMENT CONNECTION

****
NOTE: Designer will verify the type of threads used by the fire department serving the building where the sprinkler system is being installed.
****

Fire department connection shall be [projecting] [flush] type with cast brass body, a [polished brass] [chromium plated] finish, and matching wall escutcheon lettered "Auto Spkr". The connection shall have two inlets with individual self-closing clappers, caps with drip drains and chains. Female inlets shall have 2-1/2 inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963.

2.8 SPRINKLERS

Sprinklers shall be used in accordance with their listed spacing limitations. Areas where sprinklers are connected to or are a part of the dry pipe system shall be considered unheated and subject to freezing. Temperature classification shall be [ordinary] [intermediate] [_____] [as indicated]. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters shall have temperature classification in accordance with NFPA 13. Sprinklers with internal O-rings shall not be used.

2.8.1 Upright Sprinkler

Upright sprinkler shall be [brass] [chrome-plated] [white enamel finished] [_____]. Sprinkler shall have an orifice of 1/2 inch or 17/32 inch in diameter.

2.8.2 Pendent Sprinkler

****

NOTE: Delete option for larger orifice when not applicable.

****

Pendent sprinkler heads shall be the dry pendent type, unless otherwise indicated. Pendent sprinkler shall be [recessed] [semi-recessed] type with nominal 1/2 inch orifice or 17/32 inch orifice. Pendent sprinklers shall be of the fusible strut or glass bulb type and shall have a [polished chrome] [white enamel] [_____] finish. Assembly shall include an integral escutcheon. Maximum length shall not exceed the maximum length indicated in UL Fire Prot Dir.

2.8.3 Corrosion Resistant Sprinkler

****

NOTE: The use of corrosion resistant sprinklers is generally limited to industrial type occupancies such as electroplating rooms, steam rooms, salt storage rooms, and piers and wharves.

****

Corrosion resistant sprinkler shall be [upright] [pendent] type installed in locations as indicated. Corrosion resistant coatings shall be factory-applied by the sprinkler manufacturer.

2.9 DISINFECTING MATERIALS

2.9.1 Liquid Chlorine

Liquid chlorine shall conform to AWWA B301.

2.9.2 Hypochlorites

Calcium hypochlorite and sodium hypochlorite shall conform to AWWA B300.

2.10 ACCESSORIES

2.10.1 Sprinkler Cabinet

Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required, shall be provided.

2.10.2 Pendent Sprinkler Escutcheon

Escutcheon shall be one-piece metallic type with a depth of less than 3/4 inch and suitable for installation on pendent sprinklers. The escutcheon shall have a factory finish of [polished chrome] [white enamel].

2.10.3 Pipe Escutcheon

Escutcheon shall be polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set-screw.

2.10.4 Sprinkler Guard

Guard shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers located [_____] [as indicated].

2.10.5 Identification Sign

Valve identification sign shall be minimum 6 inches wide by 2 inches high with enamel baked finish on minimum 18 gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary drain," "inspector's test," "alarm test," "alarm line," and similar wording as required to identify operational components.

2.11 ALARM INITIATING AND SUPERVISORY DEVICES

****

NOTE: Drawings must indicate and detail the connection of the waterflow pressure switch, low air and valve tamper switch to the building fire alarm system or to the base-wide fire reporting system.

****

2.11.1 Sprinkler Pressure Alarm Switch (Waterflow Alarm)

Pressure switch shall include a metal housing with a neoprene diaphragm, SPDT snap action switches and a 1/2 inch NPT male pipe thread. The switch shall have a maximum service pressure rating of 175 psi. There shall be two SPDT (Form C) contacts factory adjusted to operate at 4 to 8 psi. The switch shall be capable of being mounted in any position in the alarm line trim piping of the dry pipe valve.

2.11.2 Low Air Pressure Supervisory Switch

The pressure switch shall supervise the air pressure in system and shall be set to activate at 10 psi psi above the dry pipe valve trip point pressure. The switch shall have an adjustable range between 5 psi and 80 psi. The switch shall have screw terminal connection and shall be capable of being wired for normally open or normally closed circuit.

2.11.3 Valve Supervisory (Tamper) Switch

Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

2.12 DOUBLE-CHECK VALVE BACKFLOW PREVENTION ASSEMBLY

Double-check backflow prevention assembly shall comply with ASSE 1015. The assembly shall have a bronze, cast-iron or stainless steel body with flanged ends. The assembly shall include OS&Y shutoff valves on the inlet and outlet, 2-positive-seating check valve for continuous pressure application, and four test cocks. Assemblies shall be rated for working pressure of [150] [175] [_____] psi. The maximum pressure loss shall be 6 psi at a flow rate equal to the sprinkler water demand, at the location of the assembly.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein.

3.2 ABOVEGROUND PIPING INSTALLATION

Piping shall be run straight and bear evenly on hangers and supports.

3.2.1 Protection of Piping Against Earthquake Damage

****

NOTE: Sprinkler piping is required to be seismically protected except for those systems which are in buildings located in areas with an effective peak velocity-related acceleration (Av) of 0.10 or less. The designer shall indicate location of all building seismic separation joints. Delete this paragraph if the sprinkler system is not required to be protected against damage from earthquakes. Coordinate with structural engineer.

****

The system piping shall be protected against damage from earthquakes. Seismic protection shall include flexible couplings, sway bracing, seismic separation assemblies where piping crosses building seismic separation joints, and other features as required by NFPA 13 for protection of piping against damage from earthquakes. Branch lines shall be equipped with sway braces at the end sprinkler head and at intervals not exceeding 30 ft.

3.2.2 Piping in Exposed Areas

Exposed piping shall be installed so as not diminish exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

3.2.3 Piping in Finished Areas

In areas with suspended or dropped ceilings or with concealed spaces above the ceiling, piping shall be concealed above ceilings. Piping shall be inspected, tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas shall be concealed.

3.2.4 Pendent Sprinklers

3.2.4.1 General Locations

Sprinklers installed in the pendent position shall be of the listed dry pendent type, unless otherwise indicated. Dry pendent sprinklers shall be of the required length to permit the sprinkler to be threaded directly into a branch line tee. Hangers shall be provided on arm-overs exceeding 12 inches in length. Dry pendent sprinkler assemblies shall be such that sprinkler ceiling plates or escutcheons are of the uniform depth throughout the finished space. On pendent sprinklers installed below suspended or dropped ceilings, the distance from the sprinkler deflector to the underside of the ceiling shall not exceed 4 inches. Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer's listed range and shall be of uniform depth throughout the finished area.

3.2.4.2 Suspended Ceilings

Pendent sprinklers located in areas with suspended ceilings shall be positioned a minimum of 6 inches horizontally from the ceiling grid.

3.2.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

3.2.6 Pipe Joints

Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings and fittings shall be from the same manufacturer.

3.2.7 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved end or rubber-gasket reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2 inch.

3.2.8 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes pass through fire walls, fire partitions, or floors, a fire seal shall be placed between the pipe and sleeve in accordance with Section 07840 FIRESTOPPING. In penetrations which are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement which will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

3.2.9 Escutcheons

Escutcheons shall be provided for pipe penetrations of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

3.2.10 Inspector's Test Connection

Unless otherwise indicated, test connection shall consist of 1 inch pipe connected to a nipple up off the remote branch line; a test valve with brass plug located approximately 7 feet above the floor; nipples and union for a temporary connection; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test." The discharge orifice shall be located outside the building wall directed so as not to cause damage to adjacent construction during full flow discharge.

3.2.11 Drains

Main drain piping shall be provided to discharge [at a safe point outside the building] [at the location indicated]. Auxiliary drains shall be provided as indicated and as required by NFPA 13. When the capacity of trapped sections of pipe is less than 3 gallons, the auxiliary drain shall consist of a valve not smaller than 1/2 inch and a plug or nipple and cap. When the capacity of trapped sections of piping is more than 3 gallons, the auxiliary drain shall consist of two 1 inch valves and one 2 x 12 inch condensate nipple or equivalent, located in an accessible location. Tie-in drains shall be provided for multiple adjacent trapped branch pipes and shall be a minimum of 1 inch in diameter. Tie-in drain lines shall be pitched a minimum of 1/2 inch per 10 feet.

3.2.12 Installation of Fire Department Connection

Connection shall be mounted [on the exterior wall approximately 3 feet above finished grade] [as shown]. The piping between the connection and the check valve shall be provided with an automatic drip in accordance with NFPA 13 arranged to drain to the outside.

3.2.13 Identification Signs

Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser in accordance with NFPA 13.

3.3 UNDERGROUND PIPING INSTALLATION

****
NOTE: Restraint of the underground piping must be detailed on the drawings.
****

The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be [3] [_____] feet. The supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 6 inches above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor. In addition, joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe. Buried steel components shall be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls shall meet the requirements of Section 02510 WATER DISTRIBUTION SYSTEM.

3.4 EARTHWORK

Earthwork shall be performed in accordance with applicable provisions of Section 02315 EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS.

3.5 ELECTRICAL WORK

****
NOTE: Coordinate power and alarm requirements with the drawings and other specification sections.
****

Except as modified herein, electric equipment and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. [Alarm signal wiring connected to the building fire alarm control system shall be in accordance with Section 13850 FIRE DETECTION AND ALARM SYSTEM, DIRECT CURRENT LOOP and 13851 FIRE DETECTION AND ALARM SYSTEM,ADDRESSABLE.] [Wiring for supervisory and alarm circuits shall be [#14] [#16] AWG solid copper installed in metallic tubing or conduit.]

3.6 DISINFECTION

****
NOTE: For modification of existing systems, provide specific procedures for disinfection of new

equipment. If sprinkler piping is isolated from the domestic water piping systems by means of a reduced pressure backflow prevention assembly or if sprinkler piping in not connected to the domestic water piping, this paragraph should be deleted.
****

After all system components are installed and hydrostatic test are successfully completed, each portion of the sprinkler system to be disinfected shall be thoroughly flushed with potable water until all entrained dirt and other foreign materials have been removed before introducing chlorinating material. Flushing shall be conducted by removing the flushing fitting of the cross mains and of the grid branch lines, and then back-flushing through the sprinkler main drains. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the sprinkler piping at a constant rate of 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or liquid chlorine injected into the system through a solution-fed chlorinator and booster pump shall be used. Chlorination application shall continue until the entire system if filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system shall be opened and closed several times to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. The system shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. Samples of water in properly disinfected containers for bacterial examination will be taken from several system locations which are approved by the Contracting Officer. Samples shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method shall be either the multiple-tube fermentation technique or the membrane-filter technique. The disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system shall not be accepted until satisfactory bacteriological results have been obtained.

3.7   COLOR CODE MARKING, FIELD PAINTING AND FINISHING

****
NOTE: Designer will coordinate color code marking with Section 09900. Color code marking for piping, not listed in Table I of Section 09900, will be added to the table.
****

Color code marking of piping, field painting and finishing shall be as specified in Section 09900 PAINTING, GENERAL.

3.8   PRELIMINARY TESTS

The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. Upon completion of specified tests, the Contractor shall complete certificates as specified in paragraph SUBMITTALS.

3.8.1   Underground Piping

3.8.1.1 Flushing

Underground piping shall be flushed in accordance with NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less that the calculated maximum water demand rate of the system.

3.8.1.2 Hydrostatic Testing for Underground Piping

New underground piping shall be hydrostatically tested in accordance with NFPA 24. The allowable leakage shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 2 quarts per hour per 100 gaskets or joints, regardless of pipe diameter.

3.8.2 Aboveground Piping

3.8.2.1 Hydrostatic Testing for Aboveground Piping

Aboveground piping shall be hydrostatically tested in accordance with NFPA 13 at not less than 200 psi or 50 psi in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested. The clapper of the differential dry pipe valve shall be held off its seat during testing to prevent damage to the valve.

3.8.2.2 Air Pressure Test

As specified in NFPA 13, an air pressure leakage test at 50 psi shall be conducted for 24 hours. Any leakage that results in a loss of pressure in excess of 1.5 psi for the 24 hours shall be corrected. This air pressure test is in addition to the required hydrostatic test.

3.8.3 Testing of Alarm Devices

Each alarm initiating device, including pressure alarm switch, low air pressure switch, valve supervisory switch, and electrically-operated switch shall be tested for proper operation. Water motor alarm shall be tested. The connecting circuit [to the building fire alarm system] [and] [to the base-wide fire report system] shall be inspected and tested.

3.8.4 Trip Tests of Dry Pipe Valves

Each dry pipe valve shall be trip-tested by reducing normal system air pressure through operation the inspector's test connection. Systems equipped with quick opening devices shall be first tested without the operation of the quick opening device and then with it in operation. Test results will be witnessed and recorded. Test results shall include the number of seconds elapsed between the time the test valve is opened and tripping of the dry valve; trip-point air pressure of the dry pipe valve; water pressure prior to valve tripping; and number of seconds elapsed between time the inspector's test valve is opened and water reaches the orifice.

3.8.5 Main Drain Flow Test

Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

3.9 FINAL TEST

3.9.1 Trip Tests

A complete test of the system shall be conducted to demonstrate that the system is completely functional and meets the specified requirements. A technician employed by the installing Contractor shall be present for the final tests and shall perform or direct all tests. Tests shall include trip tests of each dry pipe valve. Each dry pipe valve shall be trip tested by reducing normal system air pressure through operation of the inspector's test connection. Systems equipped with quick opening devices shall be first tested without the operation of the quick opening device and then with it in operation. Test results shall be recorded and shall include the number of seconds elapsed between the time the test valve is opened and tripping of the dry valve; trip-point air pressure of the dry pipe valve; water pressure prior to valve tripping; number of seconds elapsed between time the inspector's test valve is opened and water reaches the orifice.

3.9.2 Alarm Tests

In conjunction with performance of trips tests, low-air pressure alarm devices shall be tested to verify proper operation. Each system shall be completely drained after each trip test. The system air supply system shall be tested to verify that system pressure is restored in the specified time. Each alarm pressure switch and associated water-operated alarm devices shall be tested.

3.9.3 Main Drain Test

After flow tests have been completed and dry pipe valves reset, the main drain test shall be conducted to assure that main control valves are in the open position. After the system has been tested and drained, the system shall be drained periodically for at least 2 weeks until it can be assured that water from the system has been removed.

3.9.4 Acceptance

The technician shall have available copies of as-built drawings and certificates of tests previously conducted. The installation will not be considered accepted until identified discrepancies have been corrected, test documentation is properly completed and received, and the system has been verified to be void of water.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-13945 (April 1998)**
U.S. ARMY CORPS OF ENGINEERS **-----------------------**
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SECTION 13945

PREACTION AND DELUGE SPRINKLER SYSTEMS, FIRE PROTECTION
04/98

****
NOTE: This guide specification covers the requirements for preaction and deluge fire protection sprinkler systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: Because preaction systems are more costly, and less reliable and require more maintenance than wet-pipe systems, they should be used only where justified by occupancy conditions. Deluge systems are "open head" systems which discharge all sprinklers upon system actuation. The use of deluge systems should be limited to special hazard situations.
****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990; R 1995) Ferritic Malleable Iron Castings
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 135	(1997) Electric-Resistance-Welded Steel Pipe
ASTM A 183	(1983; R 1998) Carbon Steel Track Bolts and Nuts
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 795	(1996) Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Cast Iron Threaded Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B18.2.1	(1996) Square and Hex Bolts and Screws Inch Series
ASME B18.2.2	(1987; R 1993) Square and Hex Nuts (Inch Series)

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1015	(1993) Double Check Backflow Prevention Assembly

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA EWW	(1995) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C111	(1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C203	(1997) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

COE TECHNICAL INSTRUCTIONS (TI)

TI 809-04	(1998) Seismic Disign for Buildings

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825a	(1998) Approval Guide Fire Protection
FM P7825b	(1998) Approval Guide Electrical Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(1996; Errata 13-96-1) Automatic Sprinkler Systems

NFPA 24	(1995) Installation of Private Fire Service Mains and Their Appurtenances
NFPA 70	(1999) National Electrical Code
NFPA 72	(1996; Errata Oct 96, Dec 96, TIA 96-1; 93-2; 96-3) National Fire Alarm Code
NFPA 1963	(1998) Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(1995) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir	(1998) Building Materials Directory
UL Fire Prot Dir	(1998) Fire Protection Equipment Directory

1.2 GENERAL REQUIREMENTS

****

NOTE: This section is written for performance design of the sprinkler piping in which the sprinkler branch lines, cross mains and the sprinkler heads are not indicated on the contract drawings. The Contractor will lay out and size the sprinkler system branch lines, cross mains and sprinkler heads. If a complete design of the sprinkler piping system is to be indicated on the contract drawings, this section will be edited to suit this design technique.

For performance designs, the contract documents must show and size all piping and equipment from the point of connection, to the sprinkler cross mains. Contract drawings will indicate, as a minimum, the location and size of the service mains, interior feed mains, control valves, sprinkler risers, and drain lines. In addition, a sprinkler riser diagram, and location of all sectional valves, inspector's test valves and switches will be indicated. The designer must clearly indicate or specify the extent or limits of coverage, the density requirements for specific areas, specific water supply data, the type and temperature ratings of sprinklers for specific areas, and other applicable information.

In areas requiring sprinkler protection, concealed spaces, such as spaces above suspended ceilings,

will be indicated to be sprinklered if they are to contain combustible construction or combustible materials.

Designer will identify on the contract drawings areas subject to freezing and will indicate appropriate means to preclude freezing of sprinkler piping.

****

The system shall consist of an automatic [preaction] [deluge] sprinkler system and shall be provided in [_____] [areas indicated on the drawings]. The sprinkler system shall provide fire sprinkler protection for the entire area. Except as modified herein, the system shall meet the requirements of NFPA 13 and NFPA 72. The sprinkler system shall be a single interlocked system that requires the actuation of an alarm initiating device to open the water control (deluge) valve. Pipe sizes which are not indicated on the drawings shall be determined by hydraulic calculations.

1.2.1 Hydraulic Design

****

NOTE: Systems covering 140 square meters (1500 square feet) or greater will be hydraulically designed. Only systems less than 140 square meters (1500 square feet) may be designed using the pipe schedule method of NFPA 13. This section must be edited if the system is to be designed using the pipe schedule method.

****

The system shall be hydraulically designed to discharge a minimum density of [_____] gpm per square foot over the hydraulically most demanding [3,000] [_____] square feet of floor area. Hydraulic calculations shall be provided in accordance with the Area/Density Method of NFPA 13.

1.2.1.1 Hose Demand

An allowance for exterior hose streams of [_____] gpm shall be added to the sprinkler system demand [at the fire hydrant shown on the drawings closest to the point where the water service enters the building.] [at the point of connection to the existing water system.]

1.2.1.2 Basis for Calculations

****

NOTE: The design must include an adequate water supply to meet the sprinkler water demand. The designer must provide water flow test results and hydraulic calculations to ensure that the system demand will be met.

Water Flow Testing: When connecting to an existing water distribution system, waterflow tests will be conducted to determine available water supply for the sprinkler system. Test results will be included as part of the concept design submission. The

designer should perform the tests or witness the testing performed by others.

Design Calculations: The designer will provide detailed hydraulic calculations that clearly demonstrate that the water supply will meet the demand of the sprinkler system and hose streams. Calculations will be submitted with the concept design submission.

****

The design of the system shall be based on a water supply which has a static pressure of [_____] psig, and a flow of [_____] gpm at a residual pressure of [_____] psig. Water supply shall be presumed available [at the point of connection to existing piping] [at the base of the riser] [_____]. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for galvanized steel piping, 140 for new cement-lined ductile-iron piping, and [100] [_____] for existing underground piping.

1.2.2 Sprinkler Spacing

Sprinklers shall be uniformly spaced on branch lines. Maximum spacing per sprinkler shall not exceed [[_____] square feet.] [limits specified in NFPA 13 for [light] [ordinary] [extra] hazard occupancy.]

1.2.3 Control System

****

NOTE: The drawings must show the following information relative to the control and detection system: preaction or deluge system control panel, source of power for control panel, fire protection valve actuation devices, detectors, manual actuation stations, waterflow pressure switches, supervisory switches; notification appliances; connection to the building fire alarm control panel or other remote monitoring systems, and all power, control, alarm, supervisory and interconnecting wiring. The designer will indicate the complete zoning of initiating devices and specify the descriptive zone labeling for the system annunciator.

All areas to be protected with preaction sprinklers must be equipped with detectors which are necessary to activate the sprinkler system.

****

The control system shall meet the requirements of NFPA 72. The control panel shall be listed in UL Fire Prot Dir or FM P7825a and FM P7825b for "Releasing Device Service". The control panel and the solenoid valve which activates the water control valves shall be compatible with each other. Compatibility shall be per specific UL listing or FM approval of the control equipment.

1.2.3.1 Power Supply

The primary operating power shall be provided from two single phase 120 VAC circuits. Transfer from normal to backup power and restoration from backup to normal power shall be fully automatic and not cause a false alarm. Loss of primary power shall not prevent actuation of the respective automatic water control valve upon activation of any alarm initiating device. Backup power shall be provided through use of rechargeable, sealed, lead calcium storage batteries.

1.2.3.2 Circuit Requirements

Alarm initiating devices shall be connected to initiating device circuits (IDC), Style [D] [_____] or to signal line circuits (SLC), Style [6] [_____], in accordance with NFPA 72. Alarm notification or indicating appliances shall be connected to indicating appliance circuit (IAC), Style [W] [X] in accordance with NFPA 72. A separate circuit shall be provided for actuation of each individual automatic water control valve. The circuits that actuate the water control valves shall be fully supervised so that the occurrence of a single open or a single ground fault condition in the interconnecting conductors shall be indicated at the control panel.

1.3 SYSTEM OPERATIONAL FEATURES

****

NOTE: Delete manual actuation stations when not required. For deluge systems, delete requirements for supervisory air pressure.

****

The system shall include a heat detection system, manual actuation stations, supervisory and alarm switches, alarm notification appliances, control panel and associated equipment. Preaction sprinkler system piping shall be provided with supervisory air pressure not to exceed 30 psig.

1.3.1 System Actuation

Activation of any [single heat detector] [2 heat detectors] or a single manual actuation station shall actuate alarm zone circuits of the control panel which, in turn, shall actuate the respective automatic water control valve. Actuation of the automatic water control valve shall cause water to [fill the preaction system piping and be discharged from fused sprinklers.] [discharge from the open sprinklers of the deluge system.]

1.3.2 Alarm Functions

****

NOTE: Drawings must indicate and detail the connection of the system control panel to the building alarm system and/or to the base-wide fire reporting system.

****

Activation of any heat detector or sprinkler pressure alarm switch or manual actuation station shall cause the illumination of the respective zone annunciator, [and activation of the building fire alarm system] [and transmission of the alarm to the base-wide fire reporting system]. Valve tamper alarm shall be monitored by the system control panel and transmitted to the building fire alarm system as a trouble alarm.

1.3.3 Supervisory Functions

The reduction of supervisory air pressure within the sprinkler system piping to less than [10] [_____] psi or the occurrence of a single open or a single ground fault in any alarm initiating device circuit, in the automatic water control valve actuation circuit, in any alarm indicating appliance circuit or in other electrically supervised circuit shall cause the individually labelled control panel trouble light to be illuminated, the audible trouble alarm to be activated, and a trouble alarm to be transmitted [to the building fire alarm control panel] [and] [to base-wide fire reporting system].

1.4 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. Submittals related to system configuration, hydraulic calculations, and equipment selection, including manufacturer's catalog data, working drawings, connection drawings, control diagrams and certificates shall be submitted concurrently as a complete package. The package will be reviewed by the U.S. Army Engineer District Fire Protection Engineer. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Load Calculations for Sizing Sway Bracing; [_____].

For systems that are required to be protected against damage from earthquakes, load calculations for sizing of sway bracing.

General Equipment Requirements; GA.

Manufacturer's Catalog Data for each piece of equipment proposed for use in the system. Data shall indicate the name of the manufacturer of each item of equipment, with data highlighted to indicate model, size, options, etc. proposed for installation. In addition, a complete equipment list which includes equipment description, model number and quantity shall be provided.

Hydraulic Calculations; GA.

Hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments.

Storage Batteries; GA.

Calculations to substantiate the total requirements for supervisory and alarm power. Ampere-hour requirements for each system component and each control panel component or module, under both normal and alarm conditions shall be included. The battery recharging period shall be provided.

Spare Parts; [_____].

Spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. A list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor shall be included.

SD-04 Drawings

Sprinkler System Shop Drawings; GA.

Detail drawings conforming to the requirements established for working plans as prescribed in NFPA 13. Drawings shall include plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.

b. Floor plans drawn to a scale not less than 1/8"= 1'-0" which clearly show locations of sprinklers, risers, pipe hangers, seismic separation assemblies, sway bracing, drains, and other applicable details necessary to clearly describe the proposed arrangement. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be indicated.

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross-mains and branch lines to finished floor and roof or ceiling. A detail shall show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

d. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical sprinkler above finished floor.

e. Details of each type of riser assembly; pipe hanger; sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building.

f. Complete point-to-point wiring diagram of the detection and control system. Indicate the detailed interconnection of control panel modules to the devices, the number and size of conductors in each conduit, and size of conduit. Connection points shall be indicated and coordinated with the terminal identification marked on the devices. Complete internal wiring schematic of the control panel and each electrical device shall be provided. Detailed description of the functions of the control panel and each module shall be provided.

As-Built Drawings; FIO.

As-built drawings, no later than [14] [_____] days after completion of the Final Tests. The sprinkler system shop drawings shall be updated to reflect as-built conditions after all associated work is completed and shall be submitted on reproducible full-size mylar film.

SD-06 Instructions

Test Procedures; GA.

Proposed test procedures for piping hydrostatic test, detection and control system tests, and trip-tests of automatic water control valve, at least 14 days prior to the start of related testing.

SD-07 Schedules

Preliminary Tests; GA.

A schedule of preliminary tests, at least 14 days prior to the proposed start of tests.

Final Test; GA.

Upon successful completion of tests specified in paragraph PRELIMINARY TESTS, written notification of the date for the final acceptance test. Notification shall be provided at least [14] [_____] days prior to the proposed start of the final test. Notification shall include a copy of the Contractor's Material & Test Certificates.

SD-08 Statements

Installer Qualifications; GA.

Qualifications of the sprinkler installer.

Submittal Preparer's Qualifications; GA.

The name and documentation of certification of the individual who will prepare the submittals, prior to the submittal of the drawings and hydraulic calculations.

SD-13 Certificates

Contractor's Material & Test Certificates; GA.

Certificates, as specified in NFPA 13, completed and signed by the Contractor's representative performing required tests for both underground and aboveground piping.

SD-19 Operation and Maintenance Manuals

Sprinkler System; [_____].

Manuals shall be in loose-leaf binder format and grouped by technical sections consisting of manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions.

The manuals shall list routine maintenance procedures, possible breakdowns, and repairs, and troubleshooting guide. This shall include procedures and instructions pertaining to frequency of preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair.

1.5 HYDRAULIC CALCULATIONS

Hydraulic calculations shall be as outlined in NFPA 13 except that calculations shall be performed by computer using software specifically designed for fire protection system design. Software which uses k-factors for typical branch lines is not acceptable. Calculations shall be taken back to the water supply source or to the point where flow test data was measured. Calculations shall substantiate that the design area indicated is the hydraulically most demanding. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculations. A summary sheet listing all sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows shall be provided. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. The diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient shall be indicated for each pipe. For grid systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. Also for grid systems, a flow diagram indicating the quantity and direction of flows shall be included. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

1.6 SUBMITTAL PREPARER'S QUALIFICATIONS

The sprinkler system submittals, including as-built drawings, shall be prepared by an individual who is either a registered professional engineer or who is certified as a Level IV Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.7 INSTALLER QUALIFICATIONS

The installer shall be experienced and regularly engaged in the installation of the type and complexity of system included in this project. A statement prior to submittal of any other data or drawings, that the proposed sprinkler system installer is regularly engaged in the installation of the type and complexity of system included in this project shall be provided. In addition, data identifying the location of at least three systems recently installed by the proposed installer which are comparable to the system specified shall be submitted. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months.

1.8 REGULATORY REQUIREMENTS

Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. Applicable material and installation standards referenced in

Appendix A of NFPA 13 and NFPA 24 shall be considered mandatory the same as if such referenced standards were specifically listed in this specification. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification shall govern. All requirements that exceed the minimum requirements of NFPA 13 shall be incorporated into the design. Reference to "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

1.9 DELIVERY AND STORAGE

Equipment placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust or other contaminants.

PART 2 PRODUCTS

2.1 GENERAL EQUIPMENT REQUIREMENTS

2.1.1 Standard Products

Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.1.2 Requirements for Fire Protection Service

Unless otherwise specified, equipment and materials shall have been tested by Underwriters Laboratories, Inc. and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM P7825a and FM P7825b. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM P7825a and FM P7825b.

2.1.3 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, voltage and current rating and catalog number on a metal plate permanently affixed to the equipment.

2.2 UNDERGROUND PIPING SYSTEMS

****

NOTE: The drawings must show service connection details and the underground water mains for the sprinkler system. The drawings must show details of the water service point-of-entry into the building and through the floor slab, and underground piping restraints, including number and size of restraining rods and thrust blocks.

****

2.2.1 Pipe

Piping from a point 6 inches above the floor to [a point 5 feet outside the building wall] [the point of connection to the existing water mains] shall be ductile iron with a rated working pressure of [150] [175] [_____] psi conforming to AWWA C151, with cement mortar lining conforming to AWWA C104. Piping more than 5 feetoutside the building walls shall comply with

Section 02510 WATER DISTRIBUTION SYSTEM.

2.2.2 Fittings and Gaskets

Fittings shall be ductile iron conforming to AWWA C110. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111.

2.2.3 Gate Valve and Indicator Posts

****

NOTE: Delete this paragraph if underground valves are not required or are specified elsewhere.

****

Gate valve for underground installation shall be of the inside screw type with counter-clockwise rotation to open. Where indicating type valves are shown or required, gate valves shall be provided with an approved indicator post of a length to permit the top of the post to be located 3 feet above finished grade. Gate valves and indicator posts shall be listed in UL Fire Prot Dir or FM P7825a and FM P7825b.

2.3 ABOVEGROUND PIPING SYSTEMS

2.3.1 Piping Systems

Sprinkler piping shall be galvanized steel pipe. The inside wall of the pipe shall be galvanized in addition to the exterior. Steel piping shall be [Schedule 40] [or] [Schedule 10] for sizes less than 8 inches in diameter and Schedule 30 or 40 for sizes 8 inches and larger in diameter. Piping shall conform to applicable provisions of ASTM A 795, ASTM A 53, or ASTM A 135. Pipe in which threads or grooves are cut shall be Schedule 40 or shall be listed by Underwriters Laboratories to have a corrosion resistance ratio (CRR) of 1.0 or greater after threads or grooves are cut. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

2.3.2 Fittings for Non-Grooved Piping

Fittings shall be cast iron conforming to ASME B16.4, galvanized steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings which use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

2.3.3 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 175 psi service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12. Gaskets shall be of silicon compound and approved for dry fire protection systems. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated.

2.3.4 Flanges

Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thick, and full face or self-centering flat ring type. Bolts shall be square-head conforming to ASME B18.2.1 and nuts shall be hexagon type conforming to ASME B18.2.2.

2.3.5 Pipe Hangers

Hangers shall be listed in UL Fire Prot Dir or FM P7825a and FM P7825b and be of the type suitable for the application, construction, and size pipe involved.

2.3.6 Valves

2.3.6.1 Control Valve and Gate Valve

****

NOTE: A control valve is required for control of each individual sprinkler riser. Where multiple risers are supplied from a single water service, riser control valves of the OS&Y type should be located in a valve room with exterior access. For more guidance on suggested locations of sprinkler control valves, refer to NFPA 13, Appendix A.

****

Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) gate valves and shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b.

2.3.6.2 Check Valves

Check valves 2 inches and larger shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b. Check valves 4 inchesand larger shall be of the swing type with flanged cast iron body and flanged inspection plates, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

2.4 AUTOMATIC WATER CONTROL VALVE (DELUGE VALVE)

****

NOTE: "Automatic water control valve" is a generic term synonymous with "deluge valve" and is used for both preaction and deluge systems. "Automatic water control valve" is consistent with what is used in the UL Fire Protection Equipment Directory. Delete reset capability when not required.

****

Automatic water control valve (deluge valve) shall be electrically-actuated and rated for a working pressure of 175 psi. Valve shall be capable of being reset without opening the valve. Electrical solenoid valve used to actuate the water control valve shall be an integral component of the valve or shall be approved for use by the water control valve manufacturer. Solenoid valve shall be rated at 24 volts direct current, and shall be normally closed type which operates when energized. Solenoid valves shall be rated for a maximum pressure differential of 175 psi. Water control valve shall be equipped with a means to prevent the valve from returning to the closed position until being manually reset. Assembly shall be complete with the valve manufacturer's standard trim piping, drain and test valves, pressure gauges, and other required appurtenances. Each assembly shall include an emergency release device for manually tripping the water control valve in the event of a power or other system failure. Device shall be a standard accessory component of the valve manufacturer and shall be labeled as to its function and method of operation. Valves located in hazardous locations shall be approved for the hazard classification of the area where located.

2.5 SUPERVISORY AIR SYSTEM

****

NOTE: Supervisory air is not appropriate for deluge systems. Delete this section and reference to supervisory air for deluge systems and for unsupervised preaction systems. The drawings will also indicate power supply to the air compressor for supervised preaction systems.

****

2.5.1 Air Compressor

Air compressor shall be single stage oilless type, air cooled, electric-motor driven, equipped with a check valve, centrifugal pressure and moisture unloader, pressure switch for automatic starting and stopping. Pressure switch shall be set to start the compressor at [20] [_____] psi and stop it at [30] [_____] psi. A safety relief valve, set to operate at [65] [_____] psi, shall be provided. The compressor shall be sized to pressurize the system to [30] [_____] psi within 30 minutes.

2.5.2 Air Pressure Maintenance Device

Device shall be a pressure regulator which automatically reduces supply air pressure to the minimum pressure required to be maintained in the piping system. The device shall have a cast bronze body and valve housing complete with diaphragm assembly, spring, filter, ball check to prevent backflow, 1/16 inch restriction to prevent rapid pressurization of the system, and adjustment screw. The device shall be capable of reducing maximum inlet pressure of 100 psi to a fixed outlet pressure adjustable to [10] [_____] psi.

2.5.3 Air Supply Piping System

Each preaction system shall be equipped with a separate pressure maintenance device, shutoff valve, bypass valve and pressure gauge. Piping shall be galvanized steel in accordance with ASTM A 795 or ASTM A 53.

2.5.4 Low Air Pressure Switch

Each preaction system shall be provided with an air pressure switch connected to the control panel. Upon reduction of supervisory air pressure to approximately [10] [_____] psig, the pressure switch shall actuate the trouble alarm device and low-air alarm light on the control panel annunciator.

2.6 WATER MOTOR ALARM ASSEMBLY

Assembly shall include a body housing, impeller wheel, drive shaft, striker assembly, gong, wall plate and related components necessary for complete operation. Minimum 3/4 inch galvanized piping shall be provided between the housing and the automatic water control valve. Drain piping from the body housing shall be minimum 1 inch galvanized steel and shall be arranged to drain to the outside of the building. Piping shall be galvanized both on the inside and on the outside surfaces.

2.7 FIRE DEPARTMENT CONNECTION

****

NOTE: Designer will verify the type of threads used by the fire department serving the building where the sprinkler system is being installed.

****

Connection shall be [projecting] [flush] type with cast brass body, a [polished brass] [chromium plated] finish, and matching wall escutcheon lettered "Auto Spkr". The connection shall have two inlets with individual self-closing clappers, caps with drip drains, and chains. Female inlets shall have 2-1/2 inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963.

2.8 SPRINKLERS

****

NOTE: Delete closed head sprinklers when not required.

Designer will indicate on the contract drawings the type of sprinkler heads for each area.

Areas that are classified as light hazard will be equipped with quick response sprinklers.

****

Sprinklers for preaction systems shall be automatic, fusible solder or glass bulb type, with a temperature classification [of ordinary] [of intermediate] [_____] [as indicated]. Closed-head sprinklers in high heat areas including attic spaces or in close proximity to unit heaters shall have temperature classification in accordance with NFPA 13. Sprinklers for deluge systems shall be open type without the fusible element. Sprinklers shall be used in accordance with their listed spacing limitations. Sprinklers with internal O-rings shall not be used.

2.8.1 Upright Sprinkler

Upright sprinkler shall be [brass] [chrome-plated] [white enamel finished] [_____]. Closed-head sprinklers shall be [standard response type] [quick response type which incorporates a fast acting heat responsive heat element]. Sprinkler shall have an orifice of 1/2 inch or 17/32 inch in diameter.

2.8.2 Pendent Sprinkler

Pendent sprinkler shall be [recessed] [semi-recessed] type. Pendent sprinkler shall be [chrome-plated] [white enamel finished] [_____]. Closed-head sprinkler shall be [standard response type] [quick response type which incorporates a fast acting heat responsive heat element].

Sprinkler shall have an orifice of 1/2 inch [or 17/32 inch] in diameter.

2.8.3 Corrosion Resistant Sprinkler

****

NOTE: The use of corrosion resistant sprinklers is generally limited to industrial type occupancies such as electroplating rooms, steam rooms, salt storage rooms, and piers and wharves.

****

Corrosion resistant sprinkler shall be listed in UL Fire Prot Dir. Sprinkler shall be [upright] [pendent] type installed in locations as indicated. Corrosion resistant coatings shall be factory-applied by the sprinkler manufacturer.

2.9 DISINFECTING MATERIALS

2.9.1 Liquid Chlorine

Liquid chlorine shall conform to AWWA B301.

2.9.2 Hypochlorites

Calcium hypochlorite and sodium hypochlorite shall conform to AWWA B300.

2.10 DOUBLE-CHECK VALVE BACKFLOW PREVENTION ASSEMBLY

Double-check backflow prevention assembly shall comply with ASSE 1015. The assembly shall have a bronze, cast-iron or stainless steel body with flanged ends. The assembly shall include OS&Y shutoff valves on the inlet and outlet, 2-positive-seating check valve for continuous pressure application, and four test cocks. Assemblies shall be rated for working pressure of [150] [175] [_____] psi. The maximum pressure loss shall be 6 psi at a flow rate equal to the sprinkler water demand, at the location of the assembly.

2.11 ACCESSORIES

2.11.1 Sprinkler Cabinet

Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required, shall be provided.

2.11.2 Pendent Sprinkler Escutcheon

Escutcheon shall be one-piece metallic type with a depth of less than 3/4 inch and suitable for installation on pendent sprinklers. The escutcheon shall have a factory finish of [polished chrome] [white enamel].

2.11.3 Pipe Escutcheon

Escutcheon shall be polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set-screw.

2.11.4 Sprinkler Guard

Guard shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers located [_____] [as indicated].

2.11.5 Identification Sign

Valve identification sign shall be minimum 6 inches wide x 2 inches high with enamel baked finish on minimum 18 gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary drain," "alarm test," "alarm line," and similar wording as required to identify operational components.

2.12 CONTROL PANEL

Panel shall be UL listed or FM approved for "Releasing Device Service" or shall have modules approved for this purpose. Panel shall contain all components and equipment required to provide the specified operational and supervisory functions of the system. Components shall be housed in a [surface] [flush]-mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly factory assembled and wired unit. Panel shall include integral "power on," "alarm," and "trouble" lamps with annunciation of each alarm, supervisory and trouble signal. The panel shall have prominent rigid plastic or metal identification plates for lamps, zones, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. Control panel switches shall be within the locked cabinet. A suitable means shall be provided for testing the control panel visual indicating devices (meter and lamps). Meters and lamps shall be plainly visible when the cabinet door is closed. Signals shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals.

2.12.1 Zone Annunciator

Visual annunciators shall be provided for each active zone and spare zone. A separate alarm and trouble lamp shall be provided for each zone and shall be located on exterior of cabinet door or be visible through the cabinet door. A minimum of [two] [_____] spare alarm zones that are fully operational shall be provided. Each lamp shall provide specific identification of the zone by means of a permanently attached rigid plastic or metal sign with either raised or engraved letters. Zone identification shall consist of a unique zone number as well as a word description of the zone.

2.12.2 System Zoning

****

NOTE: As a minimum, the system will be zoned by type of device and by floor or by specific location.

****

The system shall be zoned as follows:

ZONE NO.	DESCRIPTION
[_____]	[_____]

2.12.3 Primary Power Supply

****
NOTE: The drawings will indicate a dedicated power supply circuit for each preaction and deluge sprinkler system control panel. The power circuit will be arranged so that power and lighting system can be shutdown for building modifications without shutting down primary power to the control panel.
****

Primary power and trouble alarm power to Control Panel shall be supplied from two 120 VAC circuits. [Power to the control panel shall be as indicated.] [A [separate panel] [fused two-pole disconnect switch] connected ahead of [the main building panel] [indicated panel] shall be provided.] [Panel shall be equipped with [two] [_____] 20-amp circuit breakers for each control panel and with key lock. [Panel] [Disconnect switch] shall be permanently marked "[PREACTION] [DELUGE] SPRINKLER SYSTEM".]

2.12.4 Emergency Power Supply

Emergency power shall be provided for system operation in the event of failure of the primary power supply and shall consist of rechargeable storage battery system. Transfer from normal to emergency power or restoration from emergency to normal power shall be automatic and shall not cause transmission of a false alarm.

2.12.4.1 Storage Batteries

Storage Batteries shall be sealed, lead-calcium type requiring no additional water. The batteries shall have ample capacity, with primary power disconnected, to operate the system for a period of 90 hours. Following this period of operation via batteries, the batteries shall have ample capacity to operate all alarm indicating devices in the alarm mode for a minimum period of [15] [_____] minutes. Battery cabinet shall be a separate [compartment at the bottom of the control panel] [cabinet]. The battery cabinet shall have twice the volume of the batteries. Batteries shall sit on a noncorrosive and nonconductive base or pad.

2.12.4.2 Battery Charger

Battery charger shall be completely automatic, with high/low charging rate, capable of restoring the batteries from full discharge to full charge within 12 hours. A separate ammeter shall be provided for indicating rate of charge. A separate voltmeter shall be provided to indicate the state of the battery charge. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly if a high rate switch is provided. Charger shall be located in control panel cabinet.

2.13 ALARM INITIATING DEVICES

2.13.1 Heat Detectors

****

NOTE: The location and type of heat detectors and alarm devices must be indicated on project drawings. Delete descriptive paragraphs of detectors which are not indicated. Alarm indicator should be used only if necessary to meet project requirements.

****

Detectors located in areas subject to moisture, exterior atmospheric conditions or hazardous locations as defined in NFPA 70 shall be approved for such locations. Detectors shall be listed or approved for 50 foot spacing between detectors. The detector shall be equipped with an alarm indicating light in its base that lights when the detector is in an alarm condition. [Five] [_____] spare detectors of each type and temperature rating shall be provided.

2.13.1.1 Rate Compensation Detector

Detector shall be of the [vertical] [horizontal] spot type with a temperature classification rating of [ordinary] [intermediate] as defined by NFPA 72. Detectors listed or approved as "rate anticipation" type will be accepted. Detector shall automatically reset when temperature drops below detector temperature rating. Detector shall be hermetically sealed. Detector shall have a temperature classification rating of [ordinary] [intermediate] as defined by NFPA 72.

2.13.1.2 Combination Fixed-Temperature and Rate-of-Rise Heat Detector

Detector shall consist of two independently operated thermal elements. The rate-of-rise portion of the detector shall consist of an air chamber, flexible metal diaphragm and a moisture-proof calibrated vent which will respond to a temperature rise exceeding 15 degrees F per minute. This portion of the detector shall be self-restoring after actuation. The fixed temperature portion of the detector shall consist of a fusible alloy which will melt and cause an alarm when the surrounding air rises above the temperature rating of the detector. The detector shall provide an external indication when the fixed temperature portion of the detector actuates. Detector shall have a temperature classification rating of [ordinary] [intermediate] as defined by NFPA 72.

2.13.1.3 Fixed-Temperature Heat Detector

Detector shall have a fusible alloy which will melt and cause an alarm when the surrounding air rises above the temperature rating of the detector. The detector shall provide an external indication upon actuation of the detector. Detector shall provide a temperature classification rating of [ordinary] [intermediate] as defined by NFPA 72.

2.13.2 Manual Actuation Station

****

NOTE: Manual actuation stations are needed for deluge systems only. Delete this paragraph for preaction systems.

****

Station shall be mounted at 42 inches above the floor, unless otherwise shown. Station shall be arranged to activate the deluge system. Station shall be dual-action type requiring two separate operations in order to cause system discharge. Station shall be colored [lime yellow] [_____] [a unique color dissimilar to color used for manual fire alarm system]. Station shall be provided with a positive visible indication of operation of the station. Station shall be weatherproof type and shall be provided with an engraved label indicating DELUGE SYSTEM.

2.13.3   Sprinkler Pressure Alarm Switch (Waterflow Alarm)

Pressure switch shall include a metal housing with a neoprene diaphragm, SPDT snap action switches. The switch shall have a service pressure rating of 175 psi. There shall be two SPDT (Form C) contacts factory adjusted to operate at 4 to 8 psi. It shall be possible to mount the switch in any position in the alarm line trim piping of the automatic water control.

2.13.4   Valve Supervisory (Tamper) Switch

Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

2.14   NOTIFICATION APPLIANCES

****

NOTE: The notification appliances are for providing local notification of a sprinkler system operation. These devices are not intended to provide general building fire alarm evacuation. Fire alarm evacuation systems are addressed in 16721 FIRE ALARM AMD ALARM SYSTEM.

****

Notification appliances shall be suitable for connection to supervised alarm indicating circuits. Appliance shall have a separate screw terminal for each conductor. The surface of the appliance shall be red in color.

2.14.1   Alarm Bell

Bell shall be 10 inch diameter, surface-mounted vibrating type with matching back box. Sound output shall be a minimum of [85] [_____] DBA at 10 feet. Bell shall operate on nominal 24 VDC. Bells shall have screw terminals for in-out wiring connection. Bells used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

2.14.2   Alarm Horn

Horn shall be surface mounted, with the matching mounting back box [surface mounted] [recessed] [[single] [double] projector,] [grill and] vibrating type suitable for use in an electrically supervised circuit. Horns shall operate on nominal 24 VDC and have screw terminals for in-out wiring connection. Sound output shall be a minimum of [85] [_____] DBA at 10 feet. Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grills.

2.15   WIRING

Wiring for alternating current (AC) circuits shall be 12 AWG minimum. Wiring for low voltage direct current (DC) circuits shall be No. [16] [14] AWG minimum. Power wiring (over 28 volts) and control wiring shall be isolated. Wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in electrical metallic tubing or in metallic conduit, except rigid plastic conduit may be used under slab-on-grade. Conductors shall be color coded. Conductors used for the same function shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections to alarm initiating, alarm indicating, supervisory, and actuation circuits are prohibited.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of publications referenced herein.

3.2 ABOVEGROUND PIPING INSTALLATION

Piping shall be installed straight and bear evenly on hangers and supports.

3.2.1 Protection of Piping Against Earthquake Damage

****

NOTE: Sprinkler piping is required to be seismically protected except for those systems which are in buildings located in areas with an effective peak velocity-related acceleration (Av) of 0.10 or less. The designer shall indicate location of all building seismic separation joints. Delete this paragraph if the sprinkler system is not required to be protected against damage from earthquakes. Coordinate with structural engineer.

****

The system piping shall be protected against damage from earthquakes. Seismic protection shall include flexible couplings, sway bracing, seismic separation assemblies where piping crosses building seismic separation joints, and other features as required by NFPA 13 for protection of piping against damage from earthquakes.

3.2.2 Piping in Exposed Areas

Exposed piping shall be installed so as not to diminish exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

3.2.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above in the ceiling, piping shall be concealed above ceilings. Piping shall be inspected, tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas shall be concealed.

3.2.4 Pendent Sprinklers

****
NOTE: Delete reference to dry pendent sprinklers, when not required.
****

Sprinklers installed in the pendent position shall be of the listed dry pendent type, unless otherwise indicated. Dry pendent sprinklers shall be of the required length to permit the sprinkler to be threaded directly into a branch line tee. Where pendent sprinklers are installed below suspended or dropped ceilings, sprinklers shall be of a uniform depth throughout the finished space. On pendent sprinklers installed below suspended or dropped ceilings, the distance from the sprinkler deflector to the underside of the ceiling shall not exceed 4 inches. Hangers shall be provided on arm-overs exceeding 12 inches in length. Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer's listed range and shall be of uniform depth throughout the finished area. Pendent sprinklers located in areas with suspended ceilings shall be positioned a minimum of 6 inches horizontally from the ceiling grid.

3.2.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

3.2.6 Pipe Joints

Pipe joints shall conform to NFPA 13. Not more than four threads shall show after joint is made up. Welded joints will be permitted, only if welding operations are performed at the contractor's fabrication shop, not at the project construction site. Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings and fittings shall be from the same manufacturer.

3.2.7 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved end or rubber-gasket reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2 inch.

3.2.8 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core drilled and provided with pipe sleeves. Each sleeve shall be of Schedule 40 galvanized steel pipe, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide the required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes pass through fire walls, fire partitions, or floors, a fire seal shall be placed between the pipe and sleeve in accordance with Section 07840 FIRESTOPPING. In penetrations which are not fire-rated or are not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement which will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

3.2.9 Escutcheons

Escutcheons shall be provided for pipe penetrations of ceilings and walls in exposed areas. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

3.2.10 Drains

Main drain piping shall be provided to discharge at a safe point outside the building. Auxiliary drains shall be provided as required by NFPA 13, except that drain valves shall be used where drain plugs are permitted. Velocity drip from fire department connection check valve shall drain to the outside. Where branch lines terminate at low points and form trapped sections, such branch lines shall be manifolded to a common drain line.

3.2.11 Installation of Fire Department Connection

Connection shall be mounted [on the exterior wall approximately 3 feet above finished grade] [as shown]. The piping between the connection and the check valve shall be provided with an automatic drip in accordance with NFPA 13 arranged to drain to the outside.

3.2.12 Identification Signs

Signs shall be affixed to each control valve, main drain, auxiliary drain, test valve, and similar valves. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13.

3.3 UNDERGROUND PIPING INSTALLATION

****

NOTE: Restraint of the underground piping must be detailed on the drawings.

****

The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be [3] [_____] feet. The supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 6 inches above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor. In addition, joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe. Buried steel components shall be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls shall meet the requirements of Section 02510 WATER DISTRIBUTION SYSTEM.

3.4 EARTHWORK

Earthwork shall be performed in accordance with applicable provisions of Section 02315 EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS.

3.5 ELECTRICAL WORK

Unless otherwise specified herein, power supply equipment and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR.

3.5.1 Overcurrent and Surge Protection

All equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 and NFPA 70. Cables and conductors which serve as communications links, except fiber optics, shall have surge protection circuits installed at each end. Fuses shall not be used for surge protection.

3.5.2 Grounding

Grounding shall be provided to building ground.

3.5.3 Wiring

System field wiring shall be installed in 3/4 inch minimum diameter electrical metallic tubing or metallic conduit. Wiring for the sprinkler system fire detection and control system shall be installed in tubing or conduits dedicated for that use only and not installed in conduit, outlet boxes or junction boxes which contain lighting and power wiring or equipment. Circuit conductors entering or leaving any mounting box, outlet box enclosure or cabinet shall be connected to screw terminals with each terminal marked and labeled in accordance with the wiring diagram. No more than one conductor shall be installed under any screw terminal. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors is not permitted. Wiring within any control equipment shall be readily accessible without removing any component parts. Conductors shall be color-coded and shall be identified within each enclosure where a connection or termination is made. Conductor identification shall be by plastic-coated, self-sticking, printed markers or by heat-shrink type sleeves. Circuits shall be wired to maintain electrical supervision so that removal of any single wire from any device shall cause a "trouble" condition on the control panel.

3.5.4 Control Panel

The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 24 inches nor more than 78 inches above the finished floor.

3.5.5 Detectors

Detectors shall be ceiling-mounted per NFPA 72 and shall be at least 12 inches from any part of any lighting fixture. Detectors shall be located at least 3 feet from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location.

3.5.6 Manual Actuation Stations

Manual actuation stations shall be mounted readily accessible and 42 inches above the finished floor.

3.5.7 Notification Appliances

Notification appliances shall be mounted a minimum of 8 feet above the finished floor unless limited by ceiling height.

3.6 DISINFECTION

****

NOTE: For modification of existing systems, provide specific procedures for disinfection of new equipment. If sprinkler piping is isolated from the domestic water piping systems by means of a reduced pressure backflow prevention assembly or if sprinkler piping in not connected to the domestic water piping, this paragraph should be deleted.

****

After all system components are installed and hydrostatic tests are successfully completed, each portion of the sprinkler system to be disinfected shall be thoroughly flushed with potable water until all entrained dirt and other foreign materials have been removed before introducing chlorinating material. Flushing shall be conducted by removing the flushing fitting of the cross mains and of the grid branch lines, and then back-flushing through the sprinkler main drains. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the sprinkler piping at a constant rate of 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or liquid chlorine injected into the system through a solution-fed chlorinator and booster pump shall be used. Chlorination application shall continue until the entire system if filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system shall be opened and closed several times to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. The system shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. Samples of water in properly disinfected containers for bacterial examination will be taken from several system locations which are approved by the Contracting Officer. Samples shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method shall be either the multiple-tube fermentation technique or the membrane-filter technique. The disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.7 COLOR CODE MARKING FIELD PAINTING AND FINISHING

****

NOTE: Designer will coordinate color code marking with Section 09900. Color code marking for piping not listed in Table I of Section 09900 will be added to the table.

****

Color code marking of piping, field painting and finishing shall be as specified in Section 09900 PAINTING, GENERAL.

3.8 PRELIMINARY TESTS

The system including the underground water mains, the aboveground piping, detectors and control system and system components shall be tested to assure that equipment and components function as intended. Upon completion of specified tests, the contractor shall complete certificates as specified in paragraph SUBMITTALS.

3.8.1 Flushing

Underground water mains shall be flushed in accordance with NFPA 13 and NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less than the calculated maximum water demand rate of the system.

3.8.2 Hydrostatic Tests

The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure shall be hydrostatically tested in accordance with NFPA 13 at not less than 200 psi or 50 psi in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

3.8.3 Detection and Control System Tests

Upon completion of the installation, the detection and control system shall be subjected to functional and operational performance tests including tests of each installed initiating device, system actuation device and notification appliance. The control system tests specified in paragraph FINAL TEST shall be conducted to ensure that the system is completely functional and that wiring has been properly connected. If deficiencies are found, corrections shall be made and the system shall be retested to assure that the systems has no deficiencies.

3.8.4 Automatic Water Control Valve Test

Each water control valve shall be independently trip-tested in accordance with the manufacturer's published instructions. Each valve shall be electrically trip-tested by actuating a respective heat detector and a manual actuation station connected to the control panel and a manual actuation device which is part of the valve trim. A full-flow main drain test shall be made. For preaction systems with supervisory air, the air pressure shall be reduced to verify proper operation of the air supply system and associated supervisory alarm devices.

3.9 FINAL TEST

A complete test of the system shall be conducted to demonstrate that the system is completely functional, that required supervisory and back-up features are provided, and that the system is correctly wired. A technician employed by the installing Contractor shall be present for tests and shall provide a complete demonstration of the operation of the system. The representative shall have available copies of as-built drawings and certificates of tests previously conducted. The installation will not be accepted until all identified discrepancies have been corrected and all test documentation is properly completed and received.

3.9.1   Control System Test

****

NOTE: Listed tests are minimum required. If additional tests are required, such tests must be added to the list.

****

Testing shall be in accordance with NFPA 72. The test shall include the following:

a. Visual inspection of wiring connections.

b. Opening the circuit at each alarm initiating device, solenoid valve, and notification appliance to test the wiring and supervisory features.

c. Test of each function of the control panel.

d. Test of each circuit in the normal, open and ground fault modes.

e. Test of each initiating device in both normal and trouble conditions.

f. Test of each control circuit and device.

g. Test of each alarm notification appliance.

h. Test of the battery charger and batteries.

i. Operational tests under emergency power supply, including activation of connected alarm notification appliances for the specified time period.

3.9.2   Trip-tests of Automatic Water Control Valves

Each water control valve shall be independently trip-tested in accordance with the manufacturer's published instructions. Each valve shall be electrically trip-tested by actuating a respective heat detector, a manual actuation station connected to the system control panel and the manual release which is part of the valve trim. Each valve shall be returned to normal condition after each test. Prior to trip testing sprinkler deluge system, precautionary steps shall be taken to prevent water damage to the building and equipment from sprinkler discharge. [Control valves on deluge systems shall be shut off immediately after automatic water control valve trips.] [Control valves on deluge systems shall remain open until open sprinklers have discharged for a minimum of [10] [_____] seconds.] [Control valves on preaction systems shall remain open until piping is filled with water.]

3.9.3   Tests of Supervisory Air System

****

NOTE: Delete this paragraph for deluge system applications and preaction systems not requiring

supervisory air.
****

Preaction system supervisory air pressure shall be reduced from the normal system pressure to the point at which a low-pressure alarm is sounded. Air pressure shall be restored to verify trouble signal restoration. Automatic start/stop features of air compressor shall be tested.

-- End of Section --

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DEPARTMENT OF THE ARMY — **CEGS-13955 (March 1999)**

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SECTION 13955

AQUEOUS FILM-FORMING FOAM (AFFF) FIRE PROTECTION SYSTEM
3/99

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NOTE: This guide specification covers requirements for foam-water AFFF fire protection sprinkler and nozzle systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

****

NOTE: The complete design of the AFFF system must be shown on the project drawings. There are no provisions in this CEGS for the Contractor to perform hydraulic calculations or to lay out the system. (For aircraft hangar applications, refer to ETL 1110-3-484.) Use sprinkler hydraulics software for hydraulic calculation of the fire protection system. Assure that the design analysis clearly describes the design approach and includes hydraulic calculations. The drawings SHOULD include complete

pipe and equipment layout WITH SPACE ENVELOPE REQUIRED FOR INSTALLATION AND OPERATION OF EACH SYSTEM COMPONENT SHOWN. THE DRAWINGS SHOULD ALSO INCLUDE sprinkler and nozzle locations, elevation views of the piping showing vertical location of sprinklers and piping with respect to the ceiling and floor heat detectors, control panels, AFFF control panel zoning, wiring, foam storage tank, pumps, and other associated equipment. Consider pipe hanger requirements when laying out the system to ensure that the Contractor can provide hangers per NFPA 13.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A13.1	(1996) Scheme for the Identification of Piping Systems

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	1990; R 1995) Ferritic Malleable Iron Castings
ASTM A 47M	(1990; R 1996) Ferritic Malleable Iron Castings (Metric)
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 183	(1983; R 1998) Carbon Steel Track Bolts and Nuts
ASTM A 312/A 312M	(1995a) Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A 351/A 351M	(1994a) Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts
ASTM A 403/A 403M	(1998) Wrought Austenitic Stainless Steel Piping Fittings
ASTM A 536	(1984; R 1993) Ductile Iron Castings

ASTM A 795	(1997) Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use

ASME INTERNATIONAL (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Gray Iron Threaded Fittings
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

AMERICAN SOCIETY OF SANITARY ENGINEERING FOR PLUMBING AND SANITARY RESEARCH (ASSE)

ASSE 1013	(1993) Reduced Pressure Principle Backflow Preventers

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

COE TECHNICAL INSTRUCTIONS (TI)

809-04	(1998) Seismic Design for Buildings

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825a	(1998) Approval Guide Fire Protection

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

MILITARY SPECIFICATIONS (MS)

MS MIL-F-24385	(Rev F; am 1) Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, For Fresh and Sea Water

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 11	(1998) Low Expansion Foam
NFPA 13	(1996; Errata 13-96-1) Automatic Sprinkler Systems
NFPA 16	(1995) Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems
NFPA 16A	(1994) Installation of Closed-Head Foam-Water Sprinkler Systems
NFPA 20	(1996; Errata Oct 96; TIA 96-1) Installation of Centrifugal Fire Pumps
NFPA 24	(1995) Installation of Private Fire Service Mains and Their Appurtenances
NFPA 70	(1999) National Electrical Code
NFPA 72	(1996; Errata Oct 96, Dec 96; TIA 96-1, 96-2, 96-3) National Fire Alarm Code
NFPA 1963	(1998) Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(1995) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

UNDERWRITERS LABORATORIES (UL)

UL Fire Prot Dir	(1998)Fire Protection Equipment Directory

1.2 GENERAL REQUIREMENTS

The system shall consist of an automatic [wet-pipe] [preaction] [deluge] foam-water fire protection system and shall be provided for the areas indicated on the drawings. Except as modified herein, the system shall meet the requirements of NFPA 11, NFPA 13, [NFPA 16,] [NFPA 16A,] NFPA 24 and NFPA 72.

1.3 SYSTEM OPERATIONAL FEATURES

****

NOTE: General operation of the system should be described here. This description is not intended to replace a controls matrix or sequence of operation otherwise required or provided on the drawings.

****

[The wet-pipe sprinkler system shall operate so that actuation of a single sprinkler will cause water to flow through the alarm check valve, foam concentrate to enter the affected proportioners, and foam-water solution to be discharged from actuated sprinklers and the nozzle system.] [The single-interlocked preaction sprinkler system (without supervisory air) shall operate so that actuation of a single heat detector or manual release will cause the automatic water control (deluge) valve to open, foam concentrate to enter the affected proportioners, and foam-water solution to be discharged from actuated sprinklers and the nozzle system.] [The deluge sprinkler system shall operate so that actuation of a single heat detector or manual release will cause the automatic water control (deluge) valve to open, foam concentrate to enter the affected proportioners, and foam-water solution to be discharged from all sprinklers on the system and the nozzle system.]

1.4 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with SECTION 01330 SUBMITTAL PROCEDURES:

SD-01 Data

AFFF System Equipment; GA.

Manufacturer's catalog data for each separate piece of equipment proposed for use in the system. Data shall indicate the name of the manufacturer of each item of equipment, with data highlighted to indicate model, size, options, etc. proposed for installation. In addition, a complete equipment list with equipment description, model number, and quantity shall be provided.

Spare Parts; [_____].

Spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. A list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor shall be included.

SD-04 Drawings

AFFF System; GA.

Detail drawings conforming to the requirements prescribed in NFPA 13; drawings shall be 30 x 42 inches. Drawings shall include plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

a. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.

b. Floor plans drawn to a scale not less than 1/8 inch equals 1 foot clearly showing locations of devices, equipment, risers, electrical power connections, flame detector viewing areas, areas covered by each nozzle, and other details required to clearly describe the proposed arrangement.

c. Piping plan for each individual sprinkler system and each nozzle system. Sprinklers, nozzles and associated piping shall be shown. Abbreviated presentation forms will not be accepted. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be identified. A separate plan shall be provided for each overhead sprinkler system and each nozzle system.

d. Piping plan and isometric drawing of the AFFF concentrate system and details of all associated pumps, valves, fittings, and other components. Drawing shall indicate all operational features including, but not limited to, settings for pump start/stop, relief valve open/close, pressure sustaining valve open/close.

e. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; and from sprinkler feed mains, crossmains and branchlines to finished floor and roof or ceiling.

f. Location of control panels, detectors, manual stations, supervisory switches, solenoids, notification appliances, and other electrical devices. In addition, conduit routing and sizes, and the number of conductors contained in each shall be indicated.

g. Longitudinal and transverse building sections showing typical branch line and crossmain pipe routing and elevation of each typical sprinkler above finished floor.

h. Equipment room layout drawings drawn to a scale of not less than 1/2 inch equals 1 foot to show details of each system component, clearances between each other and from other equipment and construction in the room.

i. Details of each type of pipe hanger, sway bracing for earthquake protection, restraint of underground water main at point-of-entry into the building, proportioners, nozzles and mounting details, AFFF system control valve header and related components.

j. Connection drawings and control diagrams indicating overall electrical and mechanical operation of the AFFF system. This shall include identification and operation of each major component of the system. Diagrams shall be supplemented with a narrative description of the system. Point-to-point wiring diagrams shall indicate foam system control panel wiring and make and model of devices and equipment connected thereto.

k. Detail drawings depicting actual wiring of AFFF pump controller and all interconnecting wiring to foam concentrate pumps and other components connected to the controller. Such drawing shall be specifically prepared for the project installation. Manufacturer's standard wiring diagrams will not be accepted.

As-built Drawings; [_____].

One set of reproducible and six copies, within 14 calendar days after successful completion of required testing. A separate set of approved submittal drawings of the overall system, marked up to indicate as-built conditions, shall be maintained on site. These drawings shall be maintained in a current condition at all times and shall be made available for review immediately upon request during normal working hours. Variations from the approved drawings, for whatever reason, including those occasioned by modifications, change orders, optional materials, and/or required for coordination between trades shall be indicated in sufficient detail to accurately reflect the as-built conditions.

SD-06 Instructions

AFFF System; GA.

A copy of the proposed diagrams and instructions for the overall AFFF system, prior to posting.

SD-08 Statements

Contractor Qualifications; GA.

Data approved, prior to submittal of any other data or drawings, to substantiate that the proposed installer is regularly engaged in the installation of the type and complexity of fire protection system included in this project. Data shall identify the location of three systems recently installed by the proposed installer which are comparable to the system specified. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months.

Final Acceptance Test Plan; GA.

Details of method proposed for required tests at Final Acceptance, including step-by-step test procedures; list of equipment to be used; names, titles, and affiliations and qualifications of personnel who will participate in the tests; methods for protecting the facility and equipment during testing; means for containing the AFFF solution during discharge tests; and proposed means for disposal. Test plan shall include a drawing showing proposed number and arrangement of fire hoses and nozzles proposed for use in testing foam proportioners. Blank forms the Contractor plans to use to record test results shall be included.

SD-09 Reports

Tests; GA.

Reports for tests, as follows:

a. Reports as outlined in NFPA 13 documenting results of flushing and hydrostatic tests.

b. Trip tests of [alarm check] [and] [automatic water control] valves.

c. Test report of AFFF concentrate proportioning system. Report shall include all pressure readings and settings of pumps, pressure sustaining valves, relief valves and similar system components. Report shall include conductivity readings for foam samples taken from each AFFF proportioner. Report shall be signed by the factory-trained technical representative employed by the AFFF concentrate manufacturer.

d. Test report of the foam system control panel and initiating and indicating devices. Report shall include a unique identifier for each device with an indication of test results. Report shall be signed by the factory-trained technician employed by the control panel manufacturer.

e. Videotapes of tests specified to be recorded.

SD-13 Certificates

Contractor's Material and Test Certificates; GA.

Certificates from manufacturers to substantiate that components, equipment and material proposed for installation and use meet requirements as specified, concurrent with submittal of manufacturer's catalog data of equipment proposed for installation. Certificates shall be on a form for this purpose or on official letterhead of the manufacturer with specified information stated as required. Certificate shall be signed by an officer of the corporation. Certificates shall be provided for the following:

a. AFFF concentrate. Certification that AFFF concentrate proposed for use has been tested and is in compliance with MS MIL-F-24385.

b. AFFF concentrate control valve. Certification that the valve is designed and, constructed as specified and will function as intended.

c. AFFF proportioning system. Certification that the foam proportioning system complies with contract specifications and manufacturer's recommendations.

d. Control panel. Certification that the control panel releasing module is electrically compatible with the electrically-actuated automatic water control valve.

SD-19 Operation and Maintenance Manuals

AFFF System; GA.

Manuals in loose-leaf binder format and grouped by technical sections consisting of manufacturer's brochures, schematics, printed instructions, general operating procedures, and safety precautions. Manuals shall include a narrative description of the sequence or sequences of operation of the overall fire protection system and a separate description for each major subsystem. Information to be provided shall include specific start/stop settings for pumps, open/close settings for all adjustable valves (including pressure sustaining and relief valves) shall be included. The manuals shall list routine maintenance procedures, possible breakdowns, and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout, and simplified wiring and control diagrams for the system as installed. The manuals shall include procedures and instructions pertaining to frequency of preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair.

1.5 SUBMITTAL PREPARER'S QUALIFICATIONS

The fire protection system submittals, including as-built drawings, shall be prepared by an individual who is either a registered professional engineer with ten years experience designing AFFF systems or who is certified as a Level IV Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.6 INSTALLER'S QUALIFICATIONS

The installer shall be experienced and regularly engaged in the installation of the type and complexity of fire protection system included in this project. A statement prior to submittal of any other data or drawings, that the proposed installer is regularly engaged in the installation of the type and complexity of system included in this project shall be provided. In addition, data identifying the locations of at least three systems recently installed by the proposed installer which are comparable to the system specified shall be submitted. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months.

1.7 REGULATORY REQUIREMENTS

The advisory provisions of NFPA standards and recommended practices specified shall be considered mandatory, as though the word "shall" had been substituted for "should" wherever it appears. In the event of a conflict between referenced NFPA standards and this specification, this specification shall govern. Reference to "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.2 REQUIREMENTS FOR FIRE PROTECTION SERVICE

All equipment and material shall have been tested by Underwriters Laboratories, and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM P7825a. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM P7825a. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement.

2.3 PRESSURE RATINGS

Valves, fittings, couplings, proportioners, alarm switches, strainers, and similar devices shall be rated for the maximum working pressures that can be experienced in the system, but in no case less than 175 psi.

2.4 NAMEPLATES

Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate permanently affixed to the item of equipment.

2.5 UNDERGROUND PIPING SYSTEMS

****

NOTE: Assure that this provision is coordinated with drawings and other specification sections.

****

Pipe shall be ductile iron pipe conforming to AWWA C151, working pressure not less than 150 psi, with cement-mortar lining conforming to AWWA C104 for piping under the building and to a point 5 feet outside the building walls. Fittings shall be ductile iron conforming to AWWA C110. Piping more than 5 feet outside the building walls shall be [outside-coated cement-lined ductile iron pipe] [provided under SECTION 02510 WATER DISTRIBUTION SYSTEM].

2.6 ABOVEGROUND PIPING SYSTEMS HANDLING WATER OR AFFF SOLUTION

2.6.1 Pipe

Pipe shall be standard weight conforming to ASTM A 795 or ASTM A 53. Pipe 6 inch diameter and smaller shall be Schedule 40. Pipe shall be marked as to the brand or name of the manufacturer, kind of pipe and the ASTM designation in accordance with the "Product Marking" provisions of the ASTM standard.

2.6.2 Grooved Fittings and Couplings

Grooved fittings, couplings and bolts shall be provided by the same manufacturer. Fittings and couplings shall be malleable iron complying with ASTM A 47 or ductile iron complying with ASTM A 536. Couplings shall be of the rigid type except that flexible type will be provided where flexible joints are specifically required by NFPA 13. Coupling gaskets shall be Grade E (EPDM) approved for dry pipe fire protection service. Gasket shall be the flush type that fills the entire cavity between the coupling and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated.

2.6.3 Non-Grooved Fittings

Non-grooved fittings shall be threaded or flanged. Threaded fittings shall be cast iron conforming to ASME B16.4 or malleable iron conforming to ASME B16.3. Flanged fittings shall be cast iron conforming to ASME B16.1. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings which require drilling a hole in the pipe, and fittings which use steel gripping devices to bite into the pipe, shall not be used.

2.6.4 Flanges and Gaskets

Flanges shall conform to NFPA 13 and ASME B16.1. Flanges shall be the type that are welded or threaded to the pipe. Flanges which are bolted to grooved pipe will not be permitted. Gaskets shall be full face type EPDM or other approved material.

2.6.5 Pipe Hangers

Hangers shall be listed in UL Fire Prot Dir or FM P7825a and be of the type suitable for the application, construction and size pipe involved.

2.6.6 Control Valve

Unless otherwise indicated, valves shall be indicating type in accordance with NFPA 13. Valves 2-1/2 inch and larger shall be flanged outside screw and yoke (OS&Y) type.

2.6.7 Check Valve

Check valves 4 inches and larger shall be flanged, swing type, cast or ductile iron body and cover, cast or ductile iron clapper with replaceable EPDM rubber facing. Valves shall be suitable for either vertical or horizontal mounting and equipped with a removable handhole cover. The direction of flow shall be indicated by an arrow cast in the valve body. The valve body shall include plugged pipe thread connections for a 2 inch drain.

2.7 ABOVEGROUND PIPING SYSTEMS HANDLING AFFF CONCENTRATE

2.7.1 Pipe

Pipe shall be standard weight stainless steel conforming to ASTM A 312/A 312M, Grade TP 304L.

2.7.2 Fittings

Seamless socket weld type or flanged type fittings shall conform to ASTM A 403/A 403M, Grade WP 304L, and shall be compatible with the pipe. Grooved type fittings and couplings shall be of Type 316 Stainless Steel conforming to ASTM A 351/A 351M.

2.7.3 Pipe Hangers

Hangers shall be listed in UL Fire Prot Dir or FM P7825a and be of the type suitable for the application, construction and size pipe involved.

2.7.4 Control Valves

Valve shall be indicating type with full port ball and operating handle that indicates the on/off position of the valve. Unit shall be socket weld or flanged type. Valve body and ball shall be of 316 stainless steel complying with ASTM A 351/A 351M. The valve handle shall be provided with a suitable and substantial means for securing the valve open with a key-operated locking device.

2.8 ALARM CHECK VALVE ASSEMBLY

****

NOTE: Specify 1724 kPa (250 psi) rated valve for applications where the working pressure exceeds, or

may exceed, 1207 kPa (175 psi).
****

Alarm check valve assembly shall be of the variable pressure type rated for working pressures of [175 psi] [250 psi]. Assembly shall be provided with standard trimmings including pressure gauges, retarding chamber, alarm line vent, testing bypass, and necessary pipe, fittings, and accessories required for a complete installation. Valve trim piping shall be brass. Such piping shall include provision for installing an alarm pressure switch in a non-interruptible arrangement whereby shutting off of other alarm devices will not shutoff the switch in the non-interruptible location.

2.9 AUTOMATIC WATER CONTROL VALVE ASSEMBLY (DELUGE VALVE)

****
NOTE: The term "automatic water control valve" is found in the FM Approval Guide and is synonymous with "special system water control valves" found in the UL Fire Protection Equipment Directory. This term is used for "deluge," "preaction" and "flow control" valves.
****

Water control valve shall be an electrically-actuated type rated for a maximum working pressure of [175 psi] [250 psi]. The control valve shall be resettable without opening the valve and without the use of special tools. Electrical solenoid valve used to actuate the water control valve shall be an integral component of the valve or shall be approved for use by the water control valve manufacturer and the control panel manufacturer. Solenoid valve shall be of the normally closed, de-energized type which opens when energized upon receipt of an electrical signal from the control panel to which it is connected. Solenoid valves used with diaphragm-type valves shall be rated for a maximum pressure equal to that of the associated valve. Water control valve shall be equipped with a means to prevent the valve from returning to the closed position until being manually reset. Assembly shall be complete with the valve manufacturer's standard trim piping, drain and test valves, pressure gauges, and other required appurtenances. Each assembly shall include an emergency release device for manually tripping the water control valve in the event of a power or other system failure. Device shall be a standard accessory component of the valve manufacturer and shall be labeled as to its function and method of operation. Valves located in hazardous locations shall be approved for the hazard classification of the area where located.

2.10 MECHANICAL ALARM DEVICE

Device shall be water-powered and shall include a body housing, impeller wheel, drive shaft, striker assembly, gong, wall plate and related components necessary for complete operation. Minimum 3/4 inch piping shall be provided between the housing and the alarm line trim. Drain piping from the body housing shall be minimum 1 inch steel and shall be arranged to drain to the outside of the building. Piping shall be galvanized both on the inside and on the outside surfaces.

2.11 FIRE DEPARTMENT CONNECTION

****

NOTE: Verify the type of threads used by the local fire department.
****

Connection shall be [projecting] [flush] type with cast brass body, a [polished brass] [chromium plated] finish, and matching wall escutcheon lettered "Auto Spkr". The connection shall have two inlets with individual self-closing clappers, caps with drip drains, and chains. Female inlets shall have 2-1/2 inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963.

2.12 BASKET STRAINER

****
NOTE: Strainers are generally not required on systems utilizing only wet-pipe sprinklers. Indicate strainer size and friction loss limits based upon specific design.
****

Unit shall have cast iron flanged body and cover flanges. The strainer basket shall be formed of perforated brass or stainless steel sheet with 1/4 inch perforations. Strainer size shall be [_____] inch and shall have a maximum friction loss of [_____] psi at a flow rate of [_____] gpm. Assembly shall allow access to the strainer basket by removing the flange on the top of the strainer.

2.13 REDUCED PRESSURE BACKFLOW PREVENTION ASSEMBLY

****
NOTE: Backflow preventers are not required in systems supplied by dedicated fire protection storage and pumping facilities. Where systems are supplied from domestic water systems, reduced pressure type backflow preventers are required and must be located on the discharge side of booster fire pumps directly supplying the system.
****

The unit shall be capable of preventing backsiphonage and back pressure backflow from the fire protection system into the potable water system. The assembly shall include a pressure differential relief valve located in a zone between two positive seating check valves. The assembly shall include resilient seated outside stem and yoke (OS&Y) gate valves upstream and downstream of the valve and test cocks. Main valve body shall be ductile iron with fused bonded epoxy coating. The assembly shall comply with ASSE 1013 and be listed in UL Fire Prot Dir or FM P7825a.

2.14 DISCHARGE DEVICES

2.14.1 Sprinkler

Sprinkler shall be 1/2 inch orifice spray type. For deluge systems, sprinkler shall be open type without heat responsive and actuating elements. For wet-pipe or preaction systems, sprinkler shall be upright type with [standard response] [quick response] glass bulb heat responsive and actuating element having a temperature rating of [175 degrees F]

[_____]. Spare sprinklers in accordance with NFPA 13 shall be housed in metal or plastic containers.

2.14.2 Fixed Nozzle

****

NOTE: Verify availability of nozzles required to meet design flows and pressures as needed to achieve nozzle coverage indicated on the drawings.

****

Nozzle shall be of fixed constant flow type, cast brass construction [1] [1-1/2] [____] inch male NPT, suitable for use with AFFF solution. Nozzle shall be factory set for required discharge characteristic. Discharge characteristic or k-factor(s) shall be as indicated on the drawings. Nozzle discharge pattern shall be field adjustable and lockable. Nozzle flow and effective reach of discharge at various nozzle patterns shall have been determined by the manufacturer's actual discharge tests with nozzles in horizontal pattern at nozzle pressures of 50 psi, 75 psi and 100 psi. Nozzle settings shall be factory set. Field disassembly, adjustment or assembly which could alter discharge characteristic will not be permitted.

2.14.3 Oscillating Monitor Nozzle Assembly

Assembly shall include water-powered oscillator, monitor, nozzle, and related ancillary components which shall be the product of one manufacturer. Water-powered oscillating mechanism shall be equipped with a strainer. Assembly shall include a test connection for operating the oscillator from an auxiliary water source without requiring discharge through the nozzle. Angle of elevation shall be adjustable from 20 degrees below to 60 degrees above horizontal. Oscillation arc shall be adjustable from 10 degrees to 165 degrees and speed shall be adjustable from 0 degrees to 30 degrees per second. Components in contact with the AFFF solution shall be compatible with the foam concentrate and metallic components shall be brass, bronze or stainless steel. Nozzle shall be a standard model of the manufacturer and shall have a fixed discharge characteristic. Nozzle discharge characteristic shall have been determined by discharge tests. Monitor nozzle assembly shall be approved by Factory Mutual and listed in FM P7825a.

2.15 AFFF LIQUID CONCENTRATE

AFFF concentrate shall be 3 percent conforming to MS MIL-F-24385. Concentrate shall be the product of one manufacturer. Mixing of non-identical brands of concentrate will not be permitted.

2.16 DIAPHRAGM TANK BALANCED PRESSURE PROPORTIONING SYSTEM

****

NOTE: Delete paragraph PUMPED BALANCED PRESSURE PROPORTIONING SYSTEM if this paragraph is used. Specify tank to be horizontal type unless project requirements specifically require vertical.

****

Tank shall be a steel pressure vessel constructed in accordance with ASME BPV VIII Div 1. ASME label shall be permanently affixed to the tank. Tank shall be horizontally mounted on steel saddles and shall contain a full internal diaphragm (bladder) having a minimum capacity of [_____] gallons. Diaphragm shall be nylon-reinforced Buna-N rubber or other approved material conforming to the inside shape of the tank. AFFF concentrate shall be stored inside the diaphragm and the concentrate shall not be in contact with the steel tank. The tank shall have perforated PVC tubes installed inside the diaphragm to assure full displacement of the stored concentrate. Tank shall be equipped with the manufacturer's standard fittings and trim, including AFFF fill and drain connections, water fill and drain connections, and concentrate sight gauge.

2.17 PUMPED BALANCED PRESSURE PROPORTIONING SYSTEM

****
NOTE: Delete paragraph DIAPHRAGM TANK BALANCED PRESSURE PROPORTIONING SYSTEM if the following paragraphs are used.
****

2.17.1 AFFF Concentrate Storage Tank

****
NOTE: Provide seismic details, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Remove the bracketed phrase if seismic details are not provided. Sections 13080 and 15070 properly editied, must be included in the contract docments.
****

Tank shall be designed for storage of AFFF concentrate at atmospheric pressure and shall be vertical cylindrical, high density cross-linked polyethylene construction. Individual tank capacity shall be a minimum of [_____] gallons. Tank shall be translucent and equipped with level gauge strip for approximating quantity of tank contents. Tank shall be equipped with the following: inspection hatch; valved drain/fill connection; foam concentrate pump suction and return connections (with flex connectors); pressure/vacuum vent; low liquid level float switch; seismic tie downs and other accessories required for proper operationshall be in accordance with Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 16070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT [as shown on the drawings].. Openings and tank connections shall be installed at the factory, no holes shall be made in the tank shell in the field. Tank shall include necessary supports for free standing installation.

2.17.2 AFFF Concentrate Pump

****
NOTE: Pump capacity must be sufficient to supply AFFF concentrate under design conditions with operation of sprinklers and nozzles as provided. Pump pressure should be approximately 206 kPa (30 psi) above maximum system water pressure.

****

Pump shall be a positive displacement rotary gear or vane type operating at a speed not greater than 1800 rpm. Pump capacity shall be [_____] gpm.

Pump discharge pressure shall be a minimum of [_____] psi. Metallic pump components in contact with AFFF concentrate shall be of bronze or stainless steel construction. Each pump shall be furnished with suction strainer, relief valve, and suction and discharge gauges. Pump shall be mounted on a carbon steel base and shall have guards over couplings. Pump shall be direct-connected to electric motor with drip-proof enclosure. Motor size shall be minimum [_____] hp.

2.17.3 AFFF Pump Controller

Controller shall be the automatic type and UL listed or FM approved for fire pump service and shall be arranged for automatic start and stop, and manual push-button stop of the AFFF pump it controls. Controller shall be completely terminally wired, ready for field connections, and mounted in a [NEMA Type 2 drip-proof] [NEMA Type 4 watertight and dust tight] enclosure arranged so that controller current carrying parts will not be less than 12 inches above the floor. The controller shall be equipped with an externally operable isolating switch which manually operates the motor circuit. Means shall be provided in the controller for measuring current for all motor circuit conductors. Controller shall cause pump to run for a minimum of ten (10) minutes prior to automatic shutdown. Automatic stopping shall be accomplished only after all starting causes have returned to normal and after the minimum pump run time has elapsed. Controller shall also cause pump to stop upon signal from low liquid level switch installed in the AFFF concentrate tank. Controller shall monitor and provide individually displayed audible and visual alarms on the front panel for loss of a phase or line power, phase reversal, low AFFF concentrate level, and pump room temperature. Each alarm lamp shall be labeled with rigid etched plastic labels. The controller shall be equipped with the following:

a. Voltage surge arresters installed per NFPA 20.

b. Bourdon tube pressure switch or a solid state pressure switch with independent high and low adjustments, automatic starting relay actuated from normally closed contacts, visual alarm lamps and supervisory power light.

c. Thermostat switch with adjustable setting to monitor the pump room temperature and to provide an alarm when temperatures falls below 40 degrees F.

d. Terminals for remote monitoring of pump running, pump power supply trouble (loss of power or phase and phase reversal), and pump room trouble (pump room temperature and low reservoir level, and for remote start.

e. A 7-day electric pressure recorder with 24-hour spring wound back-up. The pressure recorder shall provide a readout of the system pressure from 0 to 300 psi, time, and date.

2.17.4 Power Supply

****
NOTE: Verify that project drawings indicate power supply in accordance with NFPA 20 requirements.
****

The source and arrangement of power supply to the pumps shall be as shown on the drawings and in accordance with NFPA 20.

2.17.5   AFFF Pressure Maintenance Pump

****

NOTE: A pressure maintenance pump is required only if AFFF concentrate piping length exceeds 15 meters (50 ft.) or extends beyond the equipment room.

****

Pump shall be provided as indicated to maintain pressure on the AFFF concentrate distribution piping. Pump construction and components shall be similar to those provided for the primary AFFF concentrate pump. Pressure maintenance pump shall have a capacity and pressure rating of [_____] gpm at a discharge pressure of at least [_____] psi.

2.17.6   Pressure Balancing Valve

****

NOTE: This valve is used in pumped proportioning systems that do NOT utilize in-line balanced pressure proportioners (ILBP).

****

Pressure balancing valve shall be diaphragm type for balancing AFFF concentrate with water pressure. Valve body and other metallic components normally in contact with the AFFF concentrate shall be of bronze or stainless steel. Unit shall be rated for working pressure of 200 psi and shall include a manual bypass and duplex gauge for monitoring water pressure and AFFF concentrate pressure.

2.17.7   Pressure Sustaining Valve

****

NOTE: A regulating valve is used in pumped proportioning systems to maintain constant pressure to in-line balanced pressure proportioners (ILBP). Delete this paragraph for applications using pressure balancing valves instead of ILBP's.

****

Pressure regulating valve shall be a pressure sustaining back pressure type, hydraulically operated, pilot controlled, modulating type arranged to maintain constant upstream pressure in the AFFF concentrate piping system as the flow rate varies. Valve body and other metallic components normally in contact with the AFFF concentrate shall be of bronze or stainless steel construction. Valve body shall be designed with flat-faced flanges to match flanges of the same nominal size. Valve shall pass the unused portion of the AFFF liquid back to the storage tank under low system flow conditions. Valve shall be sized to pass the full AFFF liquid pump output of a single foam concentrate pump.

2.18   BALANCED PRESSURE PROPORTIONER (RATIO CONTROLLER)

****

NOTE: Edit this paragraph to suit the type and size or sizes of proportioners required. In-line type

proportioners can be used only with concentrate pumping systems. The size of the foam proportioner (ratio controller) used in closed-head sprinkler systems is critical. If the proportioner is too large, it may not correctly proportion at low flows, and if it is too small, it may not correctly proportion at high flows. A 150 mm (6-inch) proportioner will be appropriate for most sprinkler applications.

****

The proportioner shall be [a standard] [an in-line] balanced pressure type unit capable of proportioning AFFF liquid at 3 percent, (3 parts concentrate to 97 parts water by volume solution) at flow rates within the flow range of the proportioner. Major components of the proportioner, including the body, inlet nozzle and metering orifice shall be of brass, bronze or stainless steel. The body shall be clearly marked with a flow-direction arrow, and the type and percent of AFFF concentrate that it was designed to proportion. The proportioner size shall be [6] [_____] in and shall have a maximum friction loss of [_____] psi at a flow rate of [_____] gpm. The in-line balanced pressure proportioner shall be an assembly that includes a proportioner as described, integral pressure balancing valve with duplex pressure gauge, inlet pressure gauge and manual ball valve. The proportioner assembly shall be factory assembled and tested as an assembly by one manufacturer. Field disassembly or assembly of any component part will not be accepted. Components shall be of the make/model required by the specific UL listing or FM approval.

2.19 AFFF CONCENTRATE CONTROL VALVE ASSEMBLY

Assembly shall be specifically designed and constructed to control AFFF concentrate to proportioners and shall be arranged to open upon application of water or AFFF solution pressure from the alarm check or automatic water control valve to which it is connected. Valve shall be a listed or approved automatic control valve specifically intended for this application or a full port ball valve. All components shall be constructed of brass, bronze or stainless steel, except that the internal portions of listed or approved fire protection valves subjected to AFFF concentrate may be provided with a coating warranted by the manufacturer to protect the valve from the deleterious effects of the concentrate. All components shall be rated for working pressure of 175 psi or maximum working pressure to which they could be subjected, whichever is greater. Valve shall be certified by the manufacturer to be operable with water inlet pressure as low as 30 psi. Valve components shall be brass, bronze or stainless steel.

2.20 FOAM SYSTEM CONTROLS

****

NOTE: A foam system control panel is required for preaction and deluge sprinkler systems, as well as for systems with nozzles. Systems using "hardwired" devices are the simplest and will provide reliable service with minimum maintenance and testing. Such systems are appropriate for most applications.

****

Panel shall be UL listed or FM approved for "Releasing Device Service" or shall have modules approved for this purpose. Panel shall contain components and equipment required to provide the specified operational and supervisory functions of the system. Components shall be housed in a [surface] [flush] mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly factory assembled and wired unit. Panel shall include integral "power on," "alarm," and "trouble" lamps with annunciation of each alarm, supervisory and trouble signal. The panel shall have prominent rigid plastic or metal identification plates for zones, indicating lights, controls, meters, and switches. Lamps and fuses mounted on circuit boards shall be identified by permanent markings on the circuit board. Nameplates for fuses shall also include ampere rating. Control panel switches shall be within the locked cabinet. A suitable means shall be provided for testing the control panel visual indicating devices (meter and lamps). Meters and lamps shall be plainly visible when the cabinet door is closed. Signals shall be provided to indicate and annunciate, by zone, any alarm, supervisory or trouble condition on the system. Upon restoration of power, start-up shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals. Where the panel controls continuous linear thermal detection cable, the panel shall be fully compatible with the cable, as certified by the cable manufacturer. In such applications, the panel shall be capable of controlling multiple independent adjustable fixed temperature set points to achieve the effect of a rate-of-rise detector. The panel shall be capable of identifying the location of a hot spot along the length of the detector cable and providing a constant temperature readout.

2.20.1 Zone Annunciator

Visual annunciators shall be provided for each active zone and spare zone. A separate alarm and trouble lamp shall be provided for each zone and shall be located on the exterior of the cabinet door or be visible through the door. A minimum of [two] [_____] spare alarm zones that are fully operational shall be provided. Each lamp shall provide specific identification of the zone by means of a permanently attached rigid plastic or metal sign with either raised, engraved or silk-screened letters. Zone identification shall consist of a unique zone number as well as a word description of the zone. Zones shall be arranged as shown on the drawings.

2.20.2 System Zoning

****

NOTE: Correlate the zoning of the foam system control panel with what is shown in the riser diagram/schematic and controls matrix shown on the drawings. Differentiate groups of ALARM zones and SUPERVISORY zones as well as indicate specific devices in each circuit or zone. Generally, separate alarm initiating zones will be for heat detectors, waterflow switches, manual actuation stations, etc.

****

The system shall be zoned as follows:

ZONE NO. DESCRIPTION

[______]	[______]
[______]	[______]
[______]	[______]
[______]	[______]

2.20.3 Primary Power Supply

****

NOTE: The drawings will indicate a dedicated power supply circuit for each preaction and deluge sprinkler system control panel. The power circuit will be arranged so that power and lighting system can be shut down for building modifications without shutting down primary power to the control panel.

****

Primary power and trouble alarm power to Control Panel shall be supplied from two 120 VAC circuits. [Power to the control panel shall be as indicated.] [A [separate panel] [fused two-pole disconnect switch] connected ahead of [the main building panel] [the indicated panel] shall be provided.] Panel shall be equipped with two 20-amp circuit breakers for each control panel and with key lock. [Panel] [Disconnect switch] shall be permanently marked "FOAM FIRE PROTECTION SYSTEM".

2.20.4 Emergency Power Supply

Emergency power shall be provided for system operation in the event of failure of the primary power supply and shall consist of rechargeable storage battery system. Transfer from normal to emergency power or restoration from emergency to normal power shall be automatic and shall not cause transmission of a false alarm.

2.20.4.1 Storage Batteries

****

NOTE: Indicate if batteries will be located in a compartment within the control panel or in a separate cabinet. Delete last sentence when battery is not located within the control panel.

****

Storage Batteries shall be sealed, lead-calcium type requiring no additional water. The batteries shall have ample capacity, with primary power disconnected, to operate the system for a period of 90 hours. Following this period of operation via batteries, the batteries shall have ample capacity to operate alarm indicating devices in the alarm mode for a minimum period of [15] [_____] minutes. Battery cabinet shall be a separate [compartment within the control panel] [cabinet]. The battery compartment or cabinet shall have twice the volume of the batteries. Batteries shall set on a non-corrosive and non-conductive base or pad. Batteries in the control panel shall be located at the bottom of the panel.

2.20.4.2 Battery Charger

Battery charger shall be completely automatic, with high/low charging rate, capable of restoring the batteries from full discharge to full charge within 24 hours. A separate ammeter shall be provided for indicating rate of charge. A separate voltmeter shall be provided to indicate the state of the battery charge. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly if a high rate switch is provided. Charger shall be located in control panel cabinet.

2.21 ALARM INITIATING DEVICES

2.21.1 Waterflow Pressure Alarm Switch

****

NOTE: The adjustable retard switch is similar to the Potter Model WFSR-F and should be used where detection of sprinkler waterflow is used to perform critical functions such as actuating nozzles. This switch should be piped in the alarm valve trim such that it cannot be shutoff. The retard feature is not appropriate for use in preaction or deluge systems. "Standard" pressure switches are typically installed downstream of the retard chamber of the alarm valve alarm line trim.

****

Unit shall include a 1/2 inch NPT male pipe thread, two 1/2 inch conduit knockouts, and two sets of SPDT (Form C) contacts. The switches shall be factory adjusted to transfer the contacts at 4 to 8 psi on rising pressure. Unit shall include a water-tight NEMA 4 die-cast aluminum housing with a tamper resistant cover which requires a special key for removal. The cover shall be provided with a tamper switch which shall operate upon removal of the cover. Units used on wet-pipe systems shall have an adjustable, instantly recycling pneumatic retard to prevent false alarms due to water pressure variation. Retard adjustment shall be factory set at approximately 20-40 seconds and adjustable between 0-90 seconds.

2.21.2   Vane-type Waterflow Switch

****

NOTE: Vane-type flow switches cannot be used on preaction, deluge or other system piping which is not normally filled with water or AFFF solution.

****

Assembly shall consist of a cast aluminum pipe saddle housing an electro-mechanical device to which is attached a flexible, low-density polyethylene paddle. The paddle shall conform to the inside diameter of the fire protection pipe and sense water or solution movements. The waterflow indicator shall be capable of detecting a sustained flow exceeding 10 gpm. Assembly shall contain a pneumatic retard device adjustable from 0 to 90 seconds to reduce the possibility of false alarms caused by transient flow surges. The unit shall include two sets of SPDT (Form C) contacts. The unit shall be equipped with a silicone rubber gasket to assure positive water seal and a dustproof cover and gasket to seal the mechanism from dirt and moisture.

****

NOTE: Include description of the type of heat detection shown on drawings. Delete the

inapplicable type.
****

2.21.3   Heat Detector-Spot Type

Detector shall be weatherproof, of the rate-compensation type with a nominal temperature rating of [170] [_____] degrees F. Detector shall be listed or approved for spacing between detectors as shown. Detectors listed or approved as "rate anticipation" type will be accepted. Detectors utilizing the fixed-temperature, rate-of-rise, or combination fixed-temperature/rate-of-rise principles will not be accepted. Six spare detectors of each type and temperature rating shall be provided.

2.21.4 Continuous Linear Thermal Detector

Detector shall be line-type electrical conductivity fixed temperature coaxial wire capable of sensing temperature changes along its entire length and operate over a wide range of temperatures. The detector cable shall be constructed of a center conductor having a maximum diameter of 0.087 inch, a ceramic thermistor core and an outer metallic sheath. The center conductor shall have a maximum diameter of 0.087 inch. Individual cable sections shall be not greater than 50 ft in length and shall be equipped with hermetically sealed connectors. It shall be possible to couple together lengths of cable not greater than 50 ft together to form maximum lengths of 1,000 ft for individual circuit configurations. The detector shall be able to sense temperatures from 70 degrees F up to 1,200 degrees F and withstand temperature extremes of from -60 degrees F to 2,000 degrees F. The detector cable shall be self-restoring and thus not require replacement of affected portions of the cable after exposure to a high temperature such as would occur in a fire situation. It shall be possible to supervise the cable against an open or short circuit along the entire length of the cable such that either condition will cause a "trouble" signal on the control panel to which it is connected. The cable shall be fully compatible with the control panel to which it is connected.

2.21.5 Combination Ultraviolet-Infrared Flame Detector

Flame detector shall operate on the dual spectrum ultraviolet/infrared (UV-IR) principle. Detector shall utilize a solar-blind UV sensor with a high signal-to-noise ratio and a narrow band IR sensor. Detector logic shall require both UV and IR signals to be present, in a predetermined ratio or signature as emitted by a hydrocarbon fire, to put the detector in an alarm condition. Detector shall not respond to non-fire sources of UV or IR radiation, including intermittent or continuous solar radiation, arc welding, lightning, radiant heat, x-ray, artificial lighting, radio transmissions and jet engine exhaust.   Detector shall have an automatic through-the-lens self-testing feature. Malfunction of the detector circuitry, or degradation of the sensors' lens cleanliness to the point where the detector will not detect the design fire signature, shall cause operation of the system trouble alarm. Logic circuits necessary for operation of the detector shall be integral to the detector or located in a separate flame detector control panel mounted adjacent to the foam system control panel. Detector shall be have a 120 degrees C field-of-view, capable of operating in a temperature range of -40 to 186 degrees F, and suitable for use in Class I, Division I hazardous locations. The detector shall be listed or approved for use with the control panel to which it is connected.

2.21.6   Nozzle System Actuation Station

****
NOTE: Modify as appropriate to achieve required operation. Assure that stations are clearly labeled and distinguished from other fire alarm system stations which might be similar.
****

Unit shall be dual-action type requiring the lifting of a cover and pulling of a ring to actuate. It shall not require the breaking of glass to actuate. Unit shall be painted [lime yellow] [_____] and include a cast or engraved label indicating [Foam Nozzle System] [_____] with operating instructions clearly marked on the station cover. Alarm contacts shall have a minimum rating of 120 VAC, 60 Hz, 6 amps. Contact gap distance shall be factory set and not be field adjustable. Unit shall be compatible with the control panel to which it is connected. Unit [shall] [shall not] be listed or approved for use in hazardous locations.

2.21.6.1 Enclosure

Unit shall consist of a tamper-resistant, clear polycarbonate shield and frame that fits over the manual actuation station. The unit shall be hinged of the top and suitably labeled "Lift Here" on the bottom to indicate means of gaining access to the manual actuation station it protects. It shall include a spacer as required to accommodate its use with a surface mounted manual actuation station.

2.21.6.2 Horn

The unit shall include an 85 db at 10 ft integral horn powered by a 9 VDC alkaline battery. Upon lifting of the cover, the horn shall provide a local supervisory alarm. The enclosure shall be suitably labeled "TO ACTIVATE NOZZLES, LIFT COVER AND OPERATE STATION."

2.22 VALVE SUPERVISORY (TAMPER) SWITCH

Switch shall be designed to monitor the open condition of each water or AFFF concentrate control valve to which it is mounted. It shall include a cast aluminum housing, tamper proof cover, two sets of single pole, double throw (SPDT) contacts and brackets and J-bolts needed for mounting. Removal of the cover shall cause both switches to operate.

2.23 NOTIFICATION APPLIANCES

****
NOTE: The notification appliances are for providing local notification of a system operation. They are not intended to provide general building fire alarm evacuation. Fire alarm evacuation systems are covered in SECTION 13851, FIRE DETECTION AND ALARM SYSTEM ADDRESSABLE.
****

Notification appliances shall be suitable for connection to supervised alarm indicating circuits. Appliance shall have a separate screw terminal for each conductor.

2.23.1 Electronic Signaling Device

****

NOTE: It's important that AFFF system audible signals be distinctively different from building evacuation alarms, door alarms, etc. Because of their field-selectable sounds and higher sound output levels, electronic devices are recommended.

****

Device shall be surface-mounted type which can be mounted to a standard 4 inch square back box. Electronic device shall operate on nominal 24 VDC, shall be polarized for line supervision and shall have screw terminals for in-out wiring. Device shall be provided with three field-selectable sounds (horn, warble, siren) and three sound output levels to 102 DBA in an anechoic chamber at 10 feet.

2.23.2 Alarm Horn

Horn shall be surface mounted, with the matching mounting back box [surface mounted] [recessed] [[single] [double] projector,] [grill and] vibrating type suitable for use in an electrically supervised circuit. Horns shall operate on nominal 24 VDC and have screw terminals for in-out wiring connection. Sound output shall be a minimum of [85] [_____] DBA at 10 feet. Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grills.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Aboveground Piping

Piping shall be installed straight and bear evenly on hangers and supports. Preaction sprinkler system piping shall be pitched as if it were being installed in areas subject to freezing. Piping shall be concealed in areas with suspended ceiling and shall be inspected, tested and approved before being concealed.

3.1.1.1 Joints

Pipe joints shall conform to NFPA 13. Not more than four threads shall show after joint is made up. Joint compound shall be applied to male threads only. Joints shall be faced true, provided with gaskets and made square and tight. Flanged joints or mechanical groove couplings shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published installation instructions. All grooved couplings and fittings shall be from the same manufacturer.

3.1.1.2 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2 inch.

3.1.1.3   Sprinkler Riser Nipples (Sprigs)

Riser nipples (sprigs) 1 inch in size between sprinkler branch lines and individual sprinklers shall not be used unless necessitated by roof or ceiling conditions. In such cases, fittings shall not be installed between the branch line tee and the reducing coupling below the sprinkler.

3.1.1.4   Sprinkler Deflectors

Sprinkler deflectors shall be installed parallel to the roof or ceiling. Deflector distances from the underside of the roof or ceiling shall be in accordance with NFPA 13 except that in no case shall distance exceed 12 inches. Sprinkler clearances from obstructions shall be in accordance with NFPA 13.

3.1.1.5   Pipe Supports and Hangers

****

NOTE: To provide added protection against damage from pressure transients, specify thrust restraint for earthquake protection to be in accordance with NFPA 13 requirements for earthquake protection. Consult TI 809-04 for any aspect of seismic design.

****

Installation methods outlined in NFPA 13 are mandatory. Protection of piping against damage from earthquakes shall be provided. Longitudinal and lateral sway bracing shall be provided for piping 2-1/2 inch diameter and larger.

3.1.1.6   Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes penetrating concrete or masonry walls or concrete floors shall be provided with pipe sleeves fitted into place at the time of construction through its respective wall or floor, and shall be cut flush with each surface. Sleeve sizes and clearance between pipe and sleeve shall be in accordance with NFPA 13. Where pipes pass through fire walls, fire partitions, or floors, a fire seal shall be placed between the pipe and sleeve in accordance with SECTION 07840 FIRESTOPPING.

3.1.1.7   Piping Pitch

Piping shall be pitched to the main drain or to auxiliary drains provided as required to facilitate draining. Branch lines shall be pitched at least 1/2 inch in 10 feet and crossmains and feedmains shall be pitched to at least 1/4 inch in 10 feet.

3.1.1.8   Escutcheons

Escutcheons shall be provided at finished surfaces where exposed piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe and shall be chromium-plated iron or chromium-plated brass, either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.1.1.9   Drains

Main drain piping shall be provided to discharge at safe points outside each building. Drains shall be of adequate size to readily receive the full flow from each drain under maximum pressure. Auxiliary drains shall be provided as required by NFPA 13 except that drain valves shall be used where drain plugs are otherwise permitted. Where branch lines terminate at low points and form trapped sections, such branch lines shall be manifolded to a common drain line. Each drain valve shall be provided with a metal sign identifying the type of drain connection or function of the valve.

3.1.1.10 Identification Signs

Signs shall be in accordance with NFPA 13. Properly lettered and approved metal signs shall be suitably affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate.

3.1.2 Underground Piping

****

NOTE: Coordinate selections with drawings. Restraint of the riser under the floor will be detailed on the drawings to be consistent with the description included here.

****

The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be [3] [____] feet. The supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 6 inches) above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor. In addition, joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe. Buried steel components shall be coated with a bituminous material.

3.2 EXCAVATION, TRENCHING AND BACKFILLING

Earthwork shall be performed in accordance with applicable provisions of SECTION 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.3 ELECTRICAL WORK

Unless otherwise specified, power supply equipment and wiring shall be in accordance with SECTION 16415 ELECTRICAL WORK, INTERIOR.

3.3.1 Overcurrent and Surge Protection

Equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 and NFPA 70. Cables and conductors which serve as communication links, except fiber optics, shall have surge protection circuits installed at each end. Fuses shall not be used for surge protection.

3.3.2 Grounding

Grounding shall be provided to building ground.

3.3.3 Wiring

System field wiring shall be installed in 3/4 inch minimum diameter electrical metallic tubing or metallic conduit. Wiring for the sprinkler system fire detection and control system shall be installed in tubing or conduits dedicated for that use only and shall not be installed in conduit, outlet boxes or junction boxes which contain lighting and power wiring or equipment. Circuit conductors entering or leaving any mounting box, outlet box enclosure or cabinet shall be connected to screw terminals with each terminal marked and labeled in accordance with the wiring diagram. No more than one conductor shall be installed under any screw terminal. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors is not permitted. Wiring within any control equipment shall be readily accessible without removing any component parts. Conductors shall be color coded and shall be identified within each enclosure where a connection or termination is made. Conductor identification shall be by plastic coated, self-sticking, printed markers, or by heat-shrink type sleeves. Circuits shall be wired to maintain electrical supervision so that removal of any single wire from any device shall cause a "trouble" condition on the control panel.

3.3.4 Control Panel

The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 24 inches nor more than 78 inches above the finished floor.

3.3.5 Detectors

Detectors shall be ceiling mounted per NFPA 72 and shall be at least 12 inches from any part of any lighting fixture. Detectors shall be located at least 3 feet from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location.

3.3.6 Manual Actuation Stations

Manual actuation stations shall be mounted readily accessible and 42 inches above the finished floor.

3.3.7 Notification Appliances

Notification appliances shall be mounted a minimum of 8 feet above the finished floor unless limited by ceiling height.

3.4 PIPE PAINTING AND LABELING

3.4.1 Painting

Black steel pipe shall be painted in accordance with the requirements specified under SECTION 09900 PAINTING, GENERAL. Pipe in equipment rooms shall be painted red. Pipe in other areas shall be painted to match finishes in those areas. Stainless steel pipe shall not be painted.

3.4.2 Pipe Identification

Aboveground pipe 2 inch diameter and larger shall be identified with legends. Legends shall include FOAM CONCENTRATE, FOAM-WATER SPRINKLER, FOAM-WATER NOZZLE, and FIRE PROTECTION WATER. Legends shall utilize WHITE letters on a RED color field and shall include arrows to indicate the direction of flow. Length of color field, letter size and locations on piping shall be as recommended in ANSI A13.1.

3.5 PRELIMINARY TESTS

Tests shall be performed to make adjustments in the fire protection system operation and to verify that the system will function as intended and that it is ready for service. Such tests shall include all components and subsystems. Test results shall be clearly documented and included with the written request for Final Test.

3.5.1 Flushing

Underground water mains shall be flushed in accordance with NFPA 13 and NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less than the maximum water demand rate of the system.

3.5.2 Hydrostatic Tests

The underground and aboveground piping systems, including AFFF concentrate, shall be hydrostatically tested in accordance with NFPA 13 at not less than 200 psi, or 50 psi in excess of maximum system operating pressure, for 2 hours. There shall be no visible leakage from the piping when the system is subjected to the hydrostatic test.

3.5.3 Alarm Check and Automatic Water Control Valves

Each valve shall be tested to verify operation in accordance with manufacturer's published operating instructions. This shall include tests of valves and switches connected thereto.

3.5.4 Nozzles

Nozzles shall be discharge tested for proper operation and coverage. Oscillating nozzles shall be operated to verify that angle of elevation, angle of oscillation, and discharge range, are in accordance with requirements.

3.5.5 AFFF Concentrate System

Tests shall be conducted under the supervision of a technical representative employed by the AFFF concentrate manufacturer. The complete AFFF concentrate system shall be adjusted and tested to assure proper operation. Test results, including all pressure settings and readings, shall be recorded on an appropriate test form signed and dated by manufacturer's representative certifying that the system is in compliance with contract requirements and the manufacturer's recommended practices. Testing shall include, but not be limited to, the following:

a. Filling the AFFF concentrate tank.

b. Adjustment of pressure sustaining valves, pump relief valves, and proportioners.

c. Collection of AFFF samples and testing with a conductivity meter to verify proportioning accuracy.

d. Testing AFFF concentrate pumps for proper automatic operation. This shall include start and stop settings, automatic shutoff, and relief valve operation.

e. Testing low liquid level alarms and pump shutoff.

f. Other operational checks recommended by the AFFF proportioner manufacturer.

3.5.6 Control System Tests

****

NOTE: The specified tests are based upon preaction and deluge systems with integral detection and control systems. Revise to suit applications using wet-pipe systems.

****

Tests shall be conducted under the supervision of a factory-trained representative of the control panel manufacturer. The electrical control system shall be tested to verify that the control panel and all wiring have been installed correctly and that all components function as intended. Tests shall be conducted using normal operating and battery power. Testing shall include, but not be limited to, each of the following:

a. Alarm initiating circuit and device. This shall include heat detectors, manual actuation stations, waterflow and pressure switches, and similar devices connected to the control panel.

b. Supervisory circuit and device. This shall include valve supervisory (tamper) switches, pump power circuits, pump running, low liquid level in foam concentrate tank, and similar circuits and devices.

c. Actuation circuit and device. This shall include circuits to automatic water control valves, foam concentrate pumps, fire pumps, and similar circuits related to system activation.

d. Annunciator lamp and notification appliance. This shall include bells, horns, electronic signaling, and similar devices.

3.6 FINAL TEST

****

NOTE: This paragraph must be modified to suit specific project requirements and preferences.

****

3.6.1 Requirements

The Final Test shall be a repeat of Preliminary Tests, except that flushing and hydrostatic tests shall not be repeated. In addition, the system shall be automatically actuated and allowed to discharge for a period of at least one minute prior to shutting the system off. The Contractor shall correct system failures and other deficiencies identified during testing and shall retest portions of the system affected by the required corrections.

3.6.1.1 Pretest Requirements

The system will be considered ready for final testing only after the following have been accomplished.

a. The required test plan has been submitted and approved.

b. Preliminary tests have been made and deficiencies determined to have been corrected to the satisfaction of the equipment manufacturer's technical representatives and the Contracting Officer.

c. Test reports, including the required videotape of the preliminary tests, have been submitted and approved.

d. The control panels and detection systems shall have been in service for a break-in period of at least 14 consecutive days prior to the final test.

e. The Contractor has provided written notification to the Contracting Officer, at least [21] [_____] days prior to date of Final Test, that preliminary tests have been successfully completed.

3.6.1.2 Videotaping

Contractor shall videotape the tests in VHS format and shall record the date and time-lapse, in seconds, from start to finish of each portion of the test as directed by the Contracting Officer. Four copies of the tape shall be submitted before the system will be considered accepted.

3.6.1.3 Manufacturer's Services

Experienced technicians regularly employed by the Contractor in the installation of the system and manufacturer's representative referred to elsewhere in this specification shall conduct the testing.

3.6.1.4 Materials and Equipment

Contractor shall provide AFFF concentrate, gauges, AFFF sample collection apparatus, instruments, hose, personnel, elevating platforms, scaffolding, ladders, appliances and any other equipment necessary to fulfill testing requirements specified.

3.6.1.5 Facility and Environmental Protection

Contractor shall provide protection for the facility, including electrical and mechanical equipment exposed to possible damage during discharge tests. This shall include provision of sandbags or similar means for preventing migration of foam solution into adjacent areas. Temporary measures shall be provided to prevent AFFF solution from entering storm drains, sanitary sewers, drainage ditches, streams and other water sources. Discharged AFFF shall be contained on paved surfaces and shall not be allowed to come in contact with the earth.

3.6.2 Control System Tests

Operational features of the control system shall be tested and demonstrated. This shall include testing of control panels and each input and output circuit. Tests of circuits shall include actuation and simulated circuit fault at each initiating, notification, supervisory and actuation device or appliance. As a practical matter, these tests shall be a repeat of preliminary tests required under paragraph PRELIMINARY TESTS.

3.6.3 AFFF Proportioning System Tests

Each AFFF proportioner (ratio controller) shall be flow tested to determine that proportioning accuracy is within specified limits. Each proportioner supplying sprinkler systems with closed heads shall be tested at two flow rates; the minimum flow rate specified in the manufacturer's published data and a flow rate at least four times the minimum. Each proportioner supplying a deluge system or a nozzle system shall be tested at the design flow rate. Collecting AFFF samples from each proportioner shall be accomplished in accordance with NFPA 16, NFPA 16A and the approved test plan. Foam solution concentrations shall be determined using the methods outlined in NFPA 16 and NFPA 16A. Proportioning for nominal 3 percent concentrate shall be between 3 percent and 4 percent. If test results indicate proportioning below or above this range, the Contractor shall make necessary adjustments and retest as directed by the Contracting Officer.

3.6.4 Post-discharge Test Requirements

****

NOTE: Discharge tests using AFFF solution are necessary in order to verify proportioner accuracy as well as to demonstrate performance of the overall system at final acceptance. The collection and disposal of the solution is often a problem in many areas due to the real and perceived environmental effects of the solution. Thus it is important that the project design or the existing site addresses the need to collect and dispose of the solution. If adequate means are not otherwise available or provided, the responsibility for collection and disposal will have to be placed on the Contractor. This needs to be made clear in the project documents to preclude problems and misunderstandings at time of final testing.

****

Following the successful completion of the tests, the Contractor shall remove the foam solution from the site as indicated on the approved AFFF waste containment and disposal plan. Contractor shall replenish AFFF concentrate consumed during the tests. The entire fire protection system shall be returned to automatic operation and the facility restored to operational capability. Discharged solution shall be contained and disposed of in a manner acceptable to local authorities and as identified on the approved test plan. Once tests are completed, systems shall be returned to fully operational status, including filling of AFFF concentrate tanks with concentrate and filling of solution piping with premix as required.

3.7 POSTED INSTRUCTIONS

Framed description of system operation, instructions and schematic diagrams of the overall AFFF system and each subsystem, shall be posted where directed. Condensed operating instructions explaining the system for normal operation, refilling the AFFF storage tank, and routine testing shall be included.

3.8   TRAINING

Contractor shall provide at least two training sessions of at least 6 hours each to explain system's operation and maintenance. Training sessions shall be conducted on alternate days to afford flexibility by shift personnel and other attendees. Training sessions shall include classroom instruction and explanation of approved Operation and Maintenance Manuals. Training aids shall be provided as necessary to clearly describe the systems. In addition to classroom instruction, systems shall be operated to provide hands-on demonstrations. Contractor shall include a system actuation using water only, to demonstrate system operation and procedures for resetting the system. Training areas will be provided by the Government in the building where the systems are installed. Dates and times of the training sessions shall be coordinated with the Contracting Officer not less than 15 calendar days prior to the first session.

-- End of Section --

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EPARTMENT OF THE ARMY / **CEGS-14210 (October 1993)**
U.S. ARMY CORPS OF ENGINEERS

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 14210

ELEVATORS, ELECTRIC
10/93

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NOTE: This guide specification covers the requirements for electric passenger and freight elevators, and associated controls, door hardware and installation. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: The following will be shown on the contract drawings to accompany this specification:

1. Complete design of the hoistways, pits, machine rooms including all structural requirements, sizing, access, fire-resistant rating, ventilation, waterproofing and drainage.

2. Proper size of openings into hoistway walls for

installing hoistway door assemblies.

3. Storage facilities for elevator equipment during construction.

4. Electrical service requirements for elevators, including sizings in compliance with codes and locations for fused and unfused disconnect switches.

5. Sill supports, including steel angles, sill recesses, and grouting of door sills.

6. Structural steel door frames with extensions to beams.

7. Locations for hall stations and hall lanterns.

8. Emergency power supply with automatic time-delay transfer switch and auxiliary contacts with wiring to elevator controller.

9. Telephone and or Intercom connections to elevator hoistway.

10. Location of smoke detectors required for Firefighters' Service. The designer will also indicate wiring of the smoke detectors to the elevator control system and to the building fire alarm system.

11. Wiring to elevator alarm bells and fire-fighters' service.

12. Lighting, ventilation and heat to machine room. Ambient temperature of 10 degrees C (50 degrees F) min., 32 degrees C (90 degrees F) max.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 176	(1997) Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip

ASTM A 366/A 366M	(1997) Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
ASTM A 568/A 568M	(1998) Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A 569/A 569M	(1997) Commercial Steel (CS) Sheet and Strip Carbon (0.15 Maximum Percent), Hot-Rolled
ASTM A 666	(1996b) Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTM E 84	(1998el) Surface Burning Characteristics of Building Materials

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A17.1	(1998a) Safety Code for Elevators and Escalators
ASME A17.2.1	(1997a) Inspectors' Manual for Electric Elevators
ASME QEI-1	(1997) Standard for the Qualification of Elevator Inspectors

CODE OF FEDERAL REGULATIONS (CFR)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities

COE TECHNICAL INSTRUCTIONS (TI)

TI 809-04	(1998) Seismic Design for Buildings

FEDERAL STANDARDS (FED-STD)

FED-STD 795	(Basic) Uniform Federal Accessibility Standards

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.11	(1998) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits
IEEE C62.45	(1992) IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits
IEEE Std 304	(1977; R 1991) Test Procedure for Evaluation and Classification of Insulation Systems for Direct-Current

Machines

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO Bldg Code	(1997) Uniform Building Code (3 Vol.)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3	(1995) High-Pressure Decorative Laminates
NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3; Rev 4) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
NFPA 252	(1995) Fire Test of Door Assemblies

UNDERWRITERS LABORATORIES (UL)

UL 1449	(1996; Rev thru Oct 1998) Transient Voltage Surge Suppressors

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation. Submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Training Data; [_____].

Information describing the training course for operating personnel, training aids and samples of training aids and samples of training materials to be used, training schedules, and notification of training.

Elevator System; [_____].

A complete list of equipment and material, including illustrations, schedules, manufacturer's descriptive data and technical literature, performance charts, catalog cuts, installation instructions, brochures, diagrams, and other information required for fabrication and installation of the equipment. Data shall include calculations for reaction loads imposed on building by elevator systems. Calculations to demonstrate compliance with ASME A17.1, Rule XXIV, and to demonstrate that the proposed elevator system conforms to paragraph SEISMIC REQUIREMENTS; certified copies of test reports may be submitted on lieu of calculations. Spare parts data for each different item of material and equipment specified, after approval of detail drawings and not later than [_____] weeks prior to date of beneficial occupancy. Data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended to be replaced and replacement interval required. Data shall include the appropriate sizing of electrical protective devices.

SD-04 Drawings

Elevator System; [_____]

Detail drawings including dimensioned layouts in plan and elevation showing the arrangement of elevator equipment, anchorage of equipment, clearances for maintenance and operation; and details on hoistway, doors and frames, operation and signal stations, controllers, motors, guide rails and brackets, and points of interface with normal power [fire alarm system] [HVAC or exhaust systems] [and] [interface with emergency power systems]. Drawings shall show any revised building electrical system required to make supplied elevator system function as specified. Drawings shall contain complete wiring diagrams showing electrical connections and other details required to demonstrate sequence of operation and functions of system devices. Drawings shall include the appropriate sizing of electrical protective devices which are frequently different from National Electrical Code standard sizes.

SD-06 Instructions

Framed Instructions; [_____].

Diagrams, instructions, and other sheets, proposed for posting.

SD-08 Statements

Qualification Certificates; [_____].

Certificates of experience of elevator mechanics employed to install, supervise and test the elevator shall certify mechanics to have not less than 5 years experience installing, supervising and testing elevators of the type and rating specified. Certificate shall certify that elevator system installer is acceptable to elevator manufacturer, prior to installation of elevators.

SD-09 Reports

Testing; [_____].

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of installed system.

SD-14 Samples

Finishes; FIO.

Samples of materials and products requiring color or finish selection.

SD-18 Records

Test Procedures; GA.

A plan detailing the testing procedures shall be submitted [60] [_____] days prior to performing the elevator tests.

SD-19 Operation and Maintenance Manuals

Elevator System; GA.

[Six] [_____] copies of operation manual outlining the step-by-step procedures for system startup, operation and shutdown. Manuals shall include manufacturer's name, model number, service manual parts list and brief description of all equipment, including basic operating features. [Six] [_____] copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Manuals shall include equipment layout and complete wiring and control diagrams of the system as installed. Operation and maintenance manuals shall be approved prior to training course.

1.3 QUALIFICATIONS

Electric elevators shall be pre-engineered elevator systems, and provided by a company regularly engaged in the manufacture of elevator systems. The manufacturer shall either install the elevator system or provide letter of endorsement certifying that the elevator-system installer is acceptable to the manufacturer.

1.4 REGULATORY REQUIREMENTS

****

NOTE: Freight elevators will be required to satisfy requirements for accessibility and usability for the physically handicapped if they are used as combination passenger and freight elevators.

****

Design and fabrication shall be in accordance with ASME A17.1. Each car shall have the capacity to lift a live load, exclusive of the car and cable at a speed as specified in the following schedule. The approximate travel, terminal floors, number of stops and openings, and the car sizes shall be as shown in the schedule. The elevators shall serve the floors with stops and openings in accordance with the requirements indicated. [Passenger] [Freight] elevators shall provide accessibility and usability for physically handicapped in accordance with the requirements for the handicapped in FED-STD 795 and 36 CFR 1191.

1.4.1 Elevator Schedule (Passenger)

****

NOTE: Specify geared elevators for speeds up to 2 m/s (400 feet per minute) and gearless elevators for speeds greater than 2 m/s (400 feet per minute). Size platform in accordance with Table 207.1, ASME

A17.1.

Passenger elevators will be grouped for maximum economy and efficiency of operation. Hoisting machinery for electric traction type elevators will be located on top of shafts, preferably in penthouse type equipment rooms or adjacent to the hoistway if overhead space is not available.
****

Number of Elevators Required:	[_____].
Type:	[Geared] [Gearless].
Service:	[Passenger] [Hospital].
Capacity:	[_____] pounds.
Speed:	[_____] fpm.
Platform Size:	[_____] wide by [_____] deep.
Clear Car Inside:	[_____] wide by [_____] deep.
Net Travel:	[_____].
Landings:	[_____].
Openings: Front	[_____].
Openings: Rear	[_____].
Entrance Type:	[Center-opening horizontal sliding] [Single speed horizontal sliding] [2 speed horizontal sliding].

1.4.2 Elevator Schedule (Freight)

****
NOTE: Refer to ASME A17.1, Rule 207.2B for proper freight loading classification for the intended use. Size platform in accordance with 207.1 of ASME A17.1.

Freight elevators will be grouped for maximum economy and efficiency of operation. Hoisting machinery for electric traction type elevators will be located on top of shafts, preferably in penthouse type equipment rooms or adjacent to the hoistway if overhead space is not available.
****

Number of Elevators Required:	[_____].
Loading Classification:	ASME A17.1 Class [A] [B] [C1]

[C2] [C3].

Capacity:	[_____] pounds.
Speed:	[_____] fpm.
Platform Size:	[_____] wide by [_____] deep.
Clear Car Inside:	[_____] wide by [_____] deep.
Net Travel:	[_____] floor to [_____] floor.
Landings:	[_____].
Openings: Front	[_____].
Openings: Rear	[_____].

1.5 DESIGNATED LANDING

For the purposes of firefighter's service and emergency operations, as required by Section 211, ASME A17.1, the designated landing or level shall be the [first floor] [_____]. The alternate landing or level shall be the [_____] floor.

1.6 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity and excessive temperature variations; and dirt, or other contaminants.

1.7 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing any work.

1.8 WARRANTY

****

NOTE: If elevator system is not a new installation, revise the following as required. Following acceptance of the elevator, the government immediately becomes responsible for its maintenance.

****

Warranty service shall be provided for each elevator for a period of 12 months after date of acceptance by Contracting Officer. Warranty service shall be performed only by trained elevator mechanics during regular working hours, and shall include manufacturer's warranty requirements including but not limited to adjusting, labor and parts needed to keep the elevator in proper operation. Testing and adjustments shall be in accordance with the applicable provisions of ASME A17.1 and ASME A17.2.1. Emergency callback service shall be included and available 24 hours a day, 7 days per week, with an initial telephone response time of [one] [_____] hour and a response time of [4] [_____] hours for a mechanic to the site. Inspection and service for fire service operation [seismic requirements], [and hospital emergency service] shall be performed every [6] [_____]

months. Documentation of inspection and testing, and certification of successful operation shall be provided with each visit.

PART 2   PRODUCTS

2.1   GENERAL EQUIPMENT REQUIREMENTS

2.1.1   Standard Products

Material and equipment shall be the standard products of manufacturers regularly engaged in the fabrication of elevators and/or elevator parts, and shall essentially duplicate items which have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is available 24 hours a day, 7 days per week, with a response time of [4] [_____] hours.

2.1.2   Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, catalog number, and electrical and mechanical characteristics on a plate secured to the item of equipment.

2.1.3   Special Tools

One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment shall be provided.

2.1.4   Electrical Work

****

NOTE: Drawings will show wattage (horsepower) of motors for sizing electric feeder and electrical devices. Delete requirement for monitor if not required by length of travel.

****

Changes to the electrical distribution system required for coordination with elevator equipment shall be performed and coordinated by the Contractor, at Contractor's expense. Electrical service for elevator machines shall be [_____] volt, 60-Hertz, 3-phase, [3 wire ungrounded] [4 wire solid neutral grounded] alternating current. The elevator machine feeder for each elevator shall have a circuit breaker or fused disconnect switch located in the elevator machine room, and shall terminate at the control panel for that elevator. Electrical work shall conform to requirements in Section 16415 ELECTRICAL WORK, INTERIOR. A feeder with circuit breaker or fused disconnect switch located in the elevator machine room, shall be terminated at the control panel for each elevator. A telephone junction box and an elevator car lighting junction box shall be provided adjacent to each controller. A single-phase electrical circuit with grounded connection for video monitor shall be provided in machine room. A disconnect switch that will shutoff power to the elevator car lighting shall be provided in the elevator machine room adjacent to the elevator control panel.

2.1.5   Use of Asbestos Products

Materials and products required for manufacturing and installing elevators shall not contain asbestos.

2.2 MISCELLANEOUS MATERIALS

2.2.1 Materials for Car Enclosures

Materials for car enclosures shall meet flame spread rating 0 to 75 and smoke development 0 to 450 as tested in accordance with requirements of ASTM E 84 and as established by ASME A17.1, Rule 204.2.

2.2.2 Structural Steel

Structural steel shall be hot-rolled commercial quality carbon steel, pickled, oiled, complying with ASTM A 569/A 569M and ASTM A 568/A 568M.

2.2.3 Cold-Rolled Sheet Steel

Sheet steel shall be cold-rolled commercial quality low-carbon steel, Class 1, exposed matte finish, oiled, complying with ASTM A 366/A 366M and ASTM A 568/A 568M.

2.2.4 Stainless Steel

Stainless steel shall be ASTM A 176 Type 302/304, austenitic, corrosion-resistant with grain of belting in direction of longest dimension. Surfaces shall be smooth and without waves and shall be in compliance with ASTM A 666 and ASTM A 568/A 568M.

2.3 PASSENGER ELEVATOR CAR

2.3.1 Car Fronts

Fronts for passenger elevators shall be combination door post and return panels manufactured of 14 gauge stainless steel provided with necessary cutouts for operating devices. Operating panel shall be recessed into front return panel with surface-applied operating panel cover. Position indicator in front return shall be recessed with a surface-applied cover plate. Exposed stainless steel shall be finished with No. 4 Satin Finish, unless otherwise specified.

2.3.2 Car Doors

****
NOTE: Edit paragraph to omit finishes not required.
****

Car doors for passenger elevators shall be constructed from 16 gauge sheet steel and stainless steel cladding. Each door shall be sound-deadened and reinforced to receive required operating mechanism and hardware, and have two removable door guides per panel. Seams, screws or binding strips shall not be visible from within the car. Threshold shall be extruded aluminum with grooves for door guides. [Exposed steel shall be finished with rust-inhibitive primer and baked-enamel in a color to be selected.] [Exposed stainless steel shall be finished with No. 4 Satin Finish.] Car doors shall be equipped with a proximity-type infrared car door protective device having the following operation:

a. When doors are in full-open position, doors shall be unable to initiate closing if a person comes within the detection zone. The detection zone moves with the doors, so that if a person or object enters the zone after the doors have begun to close, the doors shall stop, then reverse to reopen. The doors shall reclose after a brief time. A passenger entering or leaving the cars shall not cause the doors to reopen unless the doors reach a predetermined proximity to the passenger.

b. After a stop is made, the doors shall remain open for a time to permit passenger transfer, after which they shall close automatically. This time interval shall be less for a car call than for a hall call or a coincident car/hall call.

c. If there is either a hall call anywhere in the group or a car call in the car in question and the doors are prevented from closing for a fixed time period, the door protective device shall be rendered inoperative, a buzzer shall sound in the car and the doors shall close at approximately half speed. Normal door operation shall resume at the next landing reached by the car.

2.3.3 Car Platform

Car platform for passenger elevators shall be fabricated from steel plates secured to a steel frame or plywood secured to a steel frame. Steel car platforms shall be assembled into a one-piece platform with top and bottom steel plates welded to structural steel frame and covered with felt and sound-isolation. Plywood car platform shall be 3/4 inch thick Exposure 1 plywood secured to structural steel frame with metal fire protection secured to underside of structural steel frame.

2.3.4 Walls

****

NOTE: Specify removable panels for office environment, and baked-enamel enclosures for residential and institutional type facilities. Edit paragraph to eliminate panel types not required.

****

Walls for passenger elevators shall be 7 feet 11-1/2 inches high from floor to the underside of lighting fixtures. Side and rear panels shall be 16 gauge sheet steel panels. [Lower portion of side and rear wall panels shall be provided with a 12 gauge stainless steel wainscoting from top of car base to a point 2 inches above top of handrail.] [Side and rear removable panels shall be applied to car walls and shall be manufactured from 3/4 inch plywood or composition board finished on front, back and edges faced with plastic laminate conforming to NEMA LD 3, general purpose type.] Panels shall be mounted on car walls in a manner permitting their reversing. Panels shall be evenly spaced with not less than two panels on each side and three panels at the rear with [3/8 inch separations backed up with stainless steel dividers] [reveal standard with manufacturer]. Vent around base shall be [provided] [concealed behind removable panels].

2.3.5 Car Top, Ceiling and Light Fixtures

****

NOTE: Coordinate with designer and specify number of footcandles required to get lighting level in passenger car to match lighting level in elevator lobby/building corridors.

****

Car top for passenger elevators shall be manufactured from 12 gauge sheet steel and shall be not less than 5-1/2 inches high with drop-ceiling and light fixtures. Ceiling shall be [1/8 inch thick translucent] [egg crate] white plastic fire-retardant light diffuser supported by [polished aluminum] [baked enamel] perimeter frame and dividers to form the drop-ceiling light fixture. Light fixtures shall be fluorescent type, flush with car ceiling, manufactured of sheet steel with flange and enclosed sides and top, baked-enamel reflector, mounted directly to outlet box. Bottom of fixtures shall be flush with car ceiling. Fluorescent light fixtures shall be dual lamp with quick-starting high-power factor, Class P ballasts, with safety lamp guard clamps on fluorescent tubes. Light level shall average at least [10] [_____] footcandles measured at the car threshold with the door closed. Part of car light fixture shall be removable to permit use of the emergency exit in top of car.

2.3.6 Emergency Exit

Car top for passenger elevators shall be manufactured with a hinged emergency exit panel of 12 gauge steel which opens up to clear the crosshead and car door operator. Emergency exit panel shall be hinged and held in place with nonremovable fastening devices at each corner, and manually openable from top of car and key-operable from inside. A minimum of 2 sides of exit panel shall lap the exit opening by 1 inch. Exits shall be equipped with electrical contacts which will prevent operation of car when exit door is open and cause the alarm bell to ring.

2.3.7 Floor Finish

Floor finish for passenger elevators shall be finished with resilient tile flooring not less than 3/16 inch thick or flexible-type homogeneous vinyl tile not less than 1/8 inch thick as specified in Section 09650 RESILIENT FLOORING. Tile shall be laid flush with the extruded aluminum platform threshold.

2.3.8 Base

****

NOTE: Use stainless steel only with stainless steel option for side walls.

****

Base for passenger elevators shall be [plastic laminate] [cove type stainless steel], 6 inches high.

2.3.9 Handrails

Handrails for passenger elevators shall be mounted on each wall and shall comply with ASME A17.1, FED-STD 795 and 36 CFR 1191. For elevators with 2-speed horizontal-slide openings the handrails shall be turned back to wall.

2.3.10 Exhaust Fan

Exhaust fan for passenger elevators shall be 2-speed exhaust type ventilating unit mounted in car ceiling and shall be provided with a [stainless steel] [chrome-plated steel] grille. Units shall be suitably isolated from car ceiling and shall provide at top speed a minimum of 6 air changes per hour for car volume and car occupancy. Switches for the operation of exhaust unit shall be located in car station locked cabinet or key-switched.

2.3.11 Communications

****

NOTE: Emergency communication in passenger elevators is required to be connected to a station which will initiate an emergency response and which is manned continuously. The designer will indicate and provide details of this connection. Refer to ASME A17.1 Rule 211.1.

****

A telephone system in stainless steel cabinet shall be provided for passenger elevators. A vandal-resistant speaker type intercom with push-button to activate shall be installed in car station behind a stainless steel perforated grille and connected to a programmable auto-dialer located in machine room. Auto-dialer shall be provided with a solid-state charger unit which will automatically provide emergency power and an immediate transfer in the event of failure of normal power supply. The push-button located in the car station or in separate cabinet shall be at the prescribed handicapped height and shall be identified as "Emergency Phone (Push to Activate)". The entire communication assembly shall be approved for an elevator installation. The telephone communication shall not be terminated until one of the communicating parties hangs up the receiver or manually disconnects the communications link.

2.3.12 Car Emergency Lighting System

Emergency car lighting system for passenger elevators shall consist of an emergency power pack on top of elevator and a remote lighting fixture inside elevator car located [in] [above] car operating panel.

2.3.12.1 Power Pack

Power pack for car emergency lighting system shall be sealed lead-cadmium or nickel-cadmium 6-volt rechargeable batteries with solid-state controls and an integral regulating charger connected to normal power supply. Power pack unit shall contain the following:

a. Minimum 6 inch diameter alarm bell connected to the elevator alarm and emergency push-button.

b. Top of car light fixture with protective wire guard.

c. Testing circuit and pilot light.

d. Low-wattage pilot light indicator.

e. Battery low-voltage disconnect.

2.3.12.2 Emergency Light Fixture

Emergency light fixture for passenger elevators shall be located in car station inside elevator car, with flush-mounted lens and shall consist of the following:

a. A minimum of two lamps capable of providing a minimum level of illumination of 1.0 footcandle at a point 4 feet above the floor, 1 foot in front of car station.

b. Fixture frame of [stainless steel] [chrome-plated steel] [steel with baked-enamel finish].

c. Frosted acrylic lenses, 1/4 inch thick.

2.3.12.3 Remote Light Fixture

Upon interruption of normal power, remote light fixture for passenger elevators shall automatically and immediately illuminate and permit operation of the bell, subject to the activation of the emergency stop-switch or alarm button. Emergency power pack shall be capable of providing a minimum of 1 hour emergency bell operation and 4 hours of continuous illumination.

2.3.13 Protection Pads

****

NOTE: Delete this paragraph in its entirety if building has a freight elevator. If freight elevator is not provided, at least one passenger elevator with pads and pad hooks shall be provided.

****

Passenger elevator No. [_____]: Car shall be provided with wall protection pads, with inconspicuous stainless steel pad hooks spaced not over 18 inches apart near ceiling. Pads shall be heavy quality fire-retardant treated canvas with two layers of sewn cotton batting with metal eyelets for each pad hook. Pads shall cover the entire wall surface except operating devices.

2.3.14 Certificate Frame

****

NOTE: Provide and locate where required by local permit and inspection agency.

****

A stainless steel certificate frame with translucent plexiglass lens of the appropriate size to receive certificate issued by inspecting agency shall be provided for passenger elevators. Frame shall be engraved to show name of elevator manufacturer, carrying capacity in pounds and maximum number of persons allowed.

2.3.15 Car and Counterweight Guides and Guide Shoes

****

NOTE: Specify not less than 150 mm (6 inch) diameter rollers for passenger type cars with speeds up to 3.5 m/s (700 feet per minute), and 250 mm (10 inch) diameter rollers for hospital type service elevators and elevators with speeds in excess of 3.5 m/s (700 feet per minute).

****

Roller guides shall consist of minimum 3 tires mounted on top and bottom of car and counterweight frame. Roller guides shall be held in contact with guide rail by adjustable devices and shall run on dry, unlubricated rails.

2.3.16 Car Guide Rails

Guide rails for passenger elevator shall be planed steel tee or omega shaped sections with structural channel rail backing as required, tongue-and-groove matched joints reinforced with fitted splice plates. Guide rails shall extend from bottom of pit to underside of roof over hoistway.

2.4 PASSENGER ELEVATOR HOISTWAY ENTRANCES

2.4.1 Hoistway Doors

****
NOTE: Specify stainless steel only when required.
****

Hoistway doors for passenger elevators shall be designed and fabricated as part of a Class B 1-1/2 hour fire-rated door/frame assembly to meet requirements of NFPA 252 and shall bear the label of an approved testing laboratory. Door panels shall be hollow metal type with plain panel design, not less than 1-1/4 inches thick with 16 gauge face sheet-steel and stainless steel cladding with 16 gauge sight guards. Each door shall be reinforced with continuous vertical members and filled with sound-deadening material. Doors shall be reinforced to accept the required operating mechanism and hardware. Doors shall have 2 removable door guides per panel. Seams, binding strips or screws shall not be visible from landing. [Exposed steel shall be finished with rust-inhibitive primer and baked-enamel in a color to be selected, unless otherwise specified]. [Exposed stainless steel shall be finished with No. 4 Satin Finish, unless otherwise specified].

2.4.2 Hoistway Frames

Hoistway frames for passenger elevators shall be designed and fabricated as part of a Class B 1-1/2 Hour fire-rated door/frame assembly to meet requirements of NFPA 252 and shall bear the label of an approved testing laboratory. Frames for passenger elevators shall be formed 14 gauge [sheet-steel] [and stainless steel cladding] with head and jamb in flush alignment and corners welded and ground smooth. Head and jamb section shall be bolted assembly with bolts, washer and locking nut or lock washer. Frame assembly shall be securely fastened to structure. Frames shall return to wall. Combination buck and jamb frames may be provided with knockdown back flanges to permit installation in concrete walls. [Exposed steel shall be finished with rust-inhibitive primer and baked-enamel in a color to be selected, unless otherwise specified.] [Exposed stainless steel shall be finished with No. 4 Satin Finish, unless otherwise specified.]

2.4.3 Symbols

Raised stainless steel symbols as required by FED-STD 795 and 36 CFR 1191 of color selected, shall be provided for passenger elevators at each floor to indicate the floor location. Symbols shall be attached with concealed fasteners. Symbols shall be placed in a location which can be seen by passengers from the opened passenger doors.

2.4.4 Sills

Sills for passenger elevators shall be extruded aluminum with slip-resistant surface and machined grooves for door guides, secured to floor beams.

2.4.5 Strut Angles

Strut angles for passenger elevators shall be structural steel of size not less than 3 x 3 x 3/16 inch extending from sill to beam above and anchored to building structure with structural steel fastenings and bracings of structural members with a cross section of not less than strut angles.

2.4.6 Door Hangers and Housing

Each door panel shall be provided with not less than 2 sheave-type hangers designed for required door operation. Hanger housing and support shall be fabricated from formed Z-shaped steel angles of size not less than 3/16 inch thick bolted to strut angles.

2.4.7 Door Rollers

Door rollers shall be constructed with grease-packed ball-bearings and shall be tired with a sound-reducing material. Diameter of rollers shall be not less than 3-1/4 inches for car doors and not less than 2-1/4 inches for hoistway doors. Upward thrust shall be taken by a hardened and ground ball-bearing roller assembled on an eccentric stud to provide adjustment.

2.4.8 Hanger Track

Hanger track shall be of high carbon cold-drawn steel, round at top to receive door rollers, and round at bottom to receive up-thrust rollers, of size engineered to accommodate load requirements.

2.4.9 Covers and Guards

Hanger covers, dust covers, toe guards, and fascia plate shall be fabricated from 16 gauge reinforced steel and finished with baked-enamel. Hanger covers shall extend the full door travel and shall be mounted in sections for ease of servicing door hangers. Dust covers shall be provided over top terminal landing door only and shall be secured to hanger housing and building structure. Toe guards shall be secured to sill. Fascia plates shall be provided between each door hanger housing and sill.

2.5 PASSENGER ELEVATOR DOOR OPERATION

****

NOTE: 1. Car "start" motion at one floor, to floor level at next consecutive floor, shall be 4.5 seconds for gearless equipment, and 5.4 seconds for geared equipment based on 3.5 m (11 feet 6 inch) floor heights. Add or subtract 0.17 second for each 0.3 m (one foot) change in floor height. For cycle time, add the aforementioned values, plus 0.07 second, plus the appropriate door times (open and close) listed below.

2. Passenger door times (seconds) are as follows:

Opening (Size Inches) (Type)	**36**	**38**	**40**	**42**	**44**	**46**	**48**
Center Opening - Open	**1.5**	**1.6**	**1.6**	**1.7**	**1.8**	**1.8**	**1.9**
Center Opening - Close	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.7**	**2.9**
2-Speed Ctr Open - Open	**--**	**--**	**--**	**1.8**	**1.9**	**2.0**	**2.1**
2-Speed Ctr Open - Close	**--**	**--**	**--**	**2.1**	**2.2**	**2.4**	**2.5**
2-Speed Slide - Open	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**
2-Speed Slide - Close	**3.3**	**3.5**	**3.6**	**3.7**	**3.9**	**4.2**	**4.5**
Single Slide - Open	**2.6**	**2.7**	**2.8**	**2.9**	**--**	**--**	
Single Slide - Close	**3.6**	**3.8**	**3.9**	**4.1**	**--**	**--**	

****

Car and hoistway doors for passenger elevators shall be operated simultaneously by an electric door operator. Doors shall operate smoothly in the opening direction and closing direction and be [electrically] [or] [hydraulically] cushioned to stop at both the full-open and full-closed position. Operators shall be high speed direct current, heavy-duty type providing an average door opening speed of 2-1/2 feet per second. Car and hoistway doors shall be opened and closed simultaneously in a maximum time of [_____] seconds. When on automatic operation the door closing time shall not exceed [_____] seconds and door closing force shall not exceed 30 pounds. Reversal of the doors when closing shall be accomplished by the "DOOR OPEN" button, car door safety edge, or interception of the photoelectric light beams. Doors shall be arranged so that doors can be opened manually in the event of power failure.

2.6 PASSENGER ELEVATOR OPERATING AND SIGNAL FIXTURES

2.6.1 General

****

NOTE: Gasketed cover plates will not be used in office buildings.

****

Elevator fixtures and panels for passenger elevators shall be constructed [of 1/8 inch thick faceplates] [in swing return] of stainless steel. Fastenings for all exposed fixtures shall be secured with tamper-proof spanner-head screws of same material and finish as fixture. Hall and car-call buttons shall be of the call register type with a low-voltage power supply not to exceed 48 volts. Pressure on a button shall illuminate button to indicate that a call in the desired direction has been registered. Car and hall fixtures shall be designed and located at the prescribed height to accommodate the handicapped in accordance with FED-STD 795 and 36 CFR 1191 for passenger elevators only. Handicapped markings shall be integral with faceplate in accordance with FED-STD 795 and 36 CFR 1191. Surface-applied markings are unacceptable. Engraving shall be black filled except for fire service identification which shall be red filled. Operating and signal fixture contacts and lamps shall be completely enclosed in steel boxes finished with baked-enamel. Boxes for hall landing devices shall be equipped for proper adjustment to wall. Lamps shall be installed in light-tight compartments. Cover plates shall be provided with rubber gaskets when exposed to weather or harmful contaminants. Replacement bulbs shall be readily available from 3 sources.

2.6.2 Car Operating Panel

****

NOTE: If a single passenger elevator or single hospital service elevator is installed, select 2-stop collective if only two floors are served, and simplex selective/collective if more than two floors are served. If two passenger elevators are served by a single passenger lobby at each landing, or two hospital service elevators are served by a single service lobby at each landing, select duplex selective/collective. If three or more passenger elevators are served by a single passenger lobby at each landing, select group operation.

****

Car operating panel for passenger elevators shall be provided with the necessary raised (0.03 inch) markings for the handicapped, and shall include a series of minimum [3/4 inch diameter] [or] [square] push-buttons numbered to correspond to the floor served and various additional switches, buttons and light jewels, including emergency stop, alarm button, "DOOR OPEN" button and [communication speaker] [telephone]. [Operating buttons shall be manufacturer's standard design.] [Operating buttons shall be vandal-resistant metal encased and embossed to permit illumination when a call is registered. Buttons shall be designed with 1/32 inch operating clearance to seat on faceplate in lieu of the button mechanism. Buttons shall have maximum protrusion of 3/16 inch beyond the faceplate and shall have beveled edges to prevent damage from side blows.] Buttons and switches not required for automatic or fire service operation shall be key-operated and mounted on front-return car operating station. Elevator number and "NO SMOKING" shall be international symbol engraved on upper portion of car station. Operating panel in the car shall consist of a flush-mounted panel containing the following operating devices:

a. "DOOR OPEN" button.

b. "DOOR CLOSE" button.

c. Key-operated car fan/light switch.

d. Key-operated ventilating blower switch/call-light.

e. Communication [speaker phone, grille and push-to-call button] [telephone].

f. Emergency stop switch [key-operated] [behind locked cover] when operated will stop the car independently of normal stopping devices. Operation of emergency stop switch shall not cause any power variance or surge that may affect the operation or condition of the control panel or its components.

g. Emergency signal-switch connected to a 6 inch diameter signal bell outside of elevator hoistway at [first floor] [_____] located as shown or as directed.

h. Key-operated independent operation switch (for multi-car only).

i. Key-operated inspection switch which will render normal operation inoperative for the purpose of using the hoistway access switch.

j. Key-operated fire service switch and light jewel.

k. Key-operated hospital emergency switch.

2.6.3 Auxiliary Car Operating Panel

****
NOTE: Specify auxiliary car operating panels for passenger elevators only, when moderate to heavy traffic is anticipated.
****

Auxiliary car operating panel for passenger elevators shall be similar in design to main car panel, and shall include all devices necessary for automatic operation, such as emergency stop switch, alarm bell, door open button, and call car buttons.

2.6.4 Hall-Call Station

****
NOTE: The number of hall-call stations per landing will be indicated on drawings. Specify vandal-resistant operating and signal fixtures for all facilities other than office environments. Specify for hospital or other institutional type facility when immediate access to elevators is mandatory for emergency purposes.
****

Hall-call operating devices for passenger elevators at landing shall consist of an "UP" push-button at bottom landing, a "DOWN" push-button at top landing and "UP" and "DOWN" push-buttons at all other landings. Push-buttons shall be [manufacturer's standard design] [vandal-resistant, metal encased and back-lighted to permit illumination when a call is registered.] Buttons shall be designed with 1/32 inch operating clearance to seat on faceplate in lieu of the button mechanism. Buttons shall have maximum protrusion of 3/16 inch beyond the faceplate with beveled edges to prevent damage from side blows.

2.6.4.1 Commandeering Switch

****
NOTE: Determine from local facility if this feature is needed, and if security can be maintained by controlling duplicate keys.
****

Key-operated commandeering switch for passenger elevators shall be provided at [each landing] [designated landings] and located in landing call-button cover plate. Switch shall be momentary pressure type with the key removable only in "OFF" position and shall be keyed to match the independent operation switch specified for car operating devices.

2.6.4.2 Fire Service Switch

Fire service switch for passenger elevators shall be located at the designated landing.

2.6.5 Direction Lanterns

****

NOTE: Hall lanterns are recommended for two or more elevators operating in a common group. Car lanterns satisfy handicapped design requirements when there is only one passenger elevator.

****

Lanterns for passenger elevators shall be in accordance with FED-STD 795 and 36 CFR 1191, and shall be provided at all floor landings and in each car entrance column. Lanterns shall be [the manufacturer's standard] [vandal-resistant] design.

2.6.6 In-Car Position Indicator

****

NOTE: Specify vandal-resistant operating and signal fixtures for all facilities other than office environments. Omit transom panel position indicator if not desired.

****

Indicator numerals and directional arrows for passenger elevators shall be [1 inch high white translucent plastic] [flush-mounted faceplate with black-filled engraved numerals not less than 1 inch high and 3/8 inch diameter vandal-resistant light jewels directly beneath each number]. As car travels through hoistway the car position shall be indicated by illumination of light jewel corresponding to landing at which the car is stopped or passing. Necessary light baffles shall be provided. Floor numerals and letters shall illuminate white. A position indicator of the digital-readout or dot-matrix type (minimum 2 inch high indication) shall be provided in car transom panel. Number corresponding to car position shall remain illuminated when motor drive is shut down. Illumination shall be shrouded in an approved manner to protect against glare from car lighting.

2.6.7 Audible Signals

[An automatic voice announcement of the floor landing at which the car stops shall be provided inside each car. In addition, an audible signal shall be provided at each floor landing and shall sound coincident with the landing lantern illumination indicator.] [An audible signal shall be provided at each floor landing and in each car and shall sound coincident with the lantern illumination indicators.] The audible signal shall be no less than 20 decibels with a frequency no higher than 1500 Hz. The audible signal shall sound once for UP direction and twice for DOWN direction.

2.6.8 Combination Hall-Position Indicator and Directional Arrows

****

NOTE: Specify hall-position indicators at main lobby for two or fewer elevators. Specify typical direction lanterns over each elevator when three or more elevators operate in a common group.

****

[Combination hall-position indicator and directional arrows for passenger elevators shall be provided at [first floor] [_____] landing directly over entrance frame.] [A digital-readout position and direction indicator (minimum 2 inch high indication) for passenger elevators shall be provided over [first floor] [_____] entrance.] As elevator travels in hoistway, elevator position shall be indicated by illumination in alpha-numeric characters corresponding to the landing where elevator is stopped or passing. Number corresponding to position of car shall remain illuminated when the motor drive is shut down. An audible signal shall sound in the elevator car to indicate that the elevator car is stopping or passing a floor served by elevator. Fixture design and operation shall be similar in design to that specified for Car Position Indicator.

2.7   PASSENGER CAR OPERATION (TWO-STOP AUTOMATIC CAR OPERATION)

****

NOTE: If a single passenger elevator or single hospital service elevator is installed, select two-stop collective if only two floors are served, and simplex selective/collective if more than two floors are served. If two passenger elevators are served by a single passenger lobby at each landing, or two hospital service elevators are served by a single service lobby at each landing, select duplex selective/collective. If three or more passenger elevators are served by a single passenger lobby at each landing, select group operation.

****

Passenger Elevator No. [_____]: The operating device at each of two hoistway landings shall consist of a single illuminating push-button. The system shall be designed for operating elevator from push-buttons at landings and car buttons marked for corresponding landings. Pressure on a car or landing button shall dispatch or call the car to other landings if interlock circuits have been established. A call shall remain registered if a lower floor landing button is pressed while car is making an upward trip. After car has reached the upper landing and interlock circuits have been reestablished the car shall automatically reverse and respond to lower landing call. Elevator shall operate similarly for DOWN direction of travel. A time-limit relay shall be provided to hold the car for a predetermined period at landing where car stops. When all calls are completed the elevator shall park [at lower floor] [at upper floor] [at last floor served] [_____]. A landing button pressed momentarily at same floor at which the car is parked shall automatically open car and hoistway doors.

2.8   PASSENGER CAR OPERATION (SINGLE-CAR SELECTIVE/COLLECTIVE)

****

NOTE: If a single passenger elevator or single hospital service elevator is installed, select two-stop collective if only two floors are served, and simplex selective/collective if more than two floors are served. If two passenger elevators are served by a single-service lobby at each landing, select duplex selective/collective. If three or

more passenger elevators are served by a single-passenger lobby at each landing, select group operation.

****

Passenger Elevator No. [_____]: Car shall be arranged so that by pressing one or more car buttons the car will start automatically and stop at [first floor] [_____] for which the button has been pressed corresponding to the direction in which the car is traveling. Car shall stop in the order in which floors are reached by car at all floors for which calls have been registered, irrespective of the sequence in which buttons have been pressed, provided the button for a given floor has been pressed sufficiently in advance of car's arrival at that floor to permit the stop to be made. If car buttons have not been pressed, and car starts UP in response to several DOWN calls, car shall travel to highest DOWN call first and then reverse to collect other UP calls. UP calls shall be collected in the same way when car starts DOWN in response to UP calls by first stopping for the lowest UP call registered. When a car has stopped in response to the pressing of a landing button and a car button is pressed corresponding to the direction in which the car has been traveling, within a predetermined interval of time after the stop, car shall continue in that direction regardless of other landing calls registered. While car is in motion, landing calls in the opposite direction of car movement shall not affect operation of car but calls shall remain registered. After the last car call in the direction the car is traveling has been answered the car shall automatically reverse and answer registered landing calls and all car calls in the order the landings are reached. When all calls have been answered, the car shall stop at the last floor served and shall have the doors closed.

2.9 PASSENGER CAR OPERATION (DUPLEX SELECTIVE/COLLECTIVE)

Passenger Elevators No. [_____] and [_____]: Cars shall be arranged so that when all calls have been answered, one car will park at the main entrance floor, the other car will remain at last floor served. A car at [first floor] [_____] or traveling UP shall continue UP until all UP landing calls are answered provided the landing buttons are pressed in time to make the stop and shall answer all DOWN landing calls behind the other car traveling DOWN. A car at the top floor traveling DOWN shall continue DOWN until all DOWN landing calls are answered provided the landing buttons are pressed in time to make the stop and shall answer all UP landing calls behind the other car traveling UP. When both cars are in operation, landing calls shall be answered by the car nearest the call and set in the direction of call. Only one car shall answer any one landing call. Operation of each car shall be such that the momentary pressing of one or more car buttons shall close the car doors in an adjustable, predetermined time after the buttons are pressed and start the car. Cars shall stop at all landings for which car or landing buttons have been pressed in the order in which the landings are reached, irrespective of the sequence in which the buttons have been pressed. If one car is out of service or fails to start, the other car shall automatically answer all calls. When cars are parked at home landing with doors closed, pressing a hall button at those floors shall illuminate lights and shall open the car doors.

2.10 GROUP SUPERVISORY SYSTEM (THREE OR MORE ELEVATORS)

2.10.1 General

Each group of elevators shall be provided with a programmable automatic supervisory group system of the microprocessor-based logic type with multiple-zoning features arranged to coordinate effectively the movement of individual elevators of the group to provide the maximum efficiency in serving the passenger service requirements. Group supervisory system shall be based upon a state of the art network of microcomputers linked together with the group supervisory computer through a high-speed data communication link.

2.10.2   Car Operation

Supervisory system shall automatically coordinate the building traffic demand from hall-call buttons to make proper assignments of calls to cars. Assignment shall provide for handling of varying traffic demands in terms of passenger waiting time and passenger transit time. As conditions change in the building, the system shall continuously update, assign and reassign hall calls to cars to keep up with the most current conditions. Group supervisory computer shall read in and evaluate system and car parameters at a rate of approximately 10 times per second.

2.10.3   Elevator Controller

Elevator controller shall utilize a microprocessor-based logic system in compliance with ASME A17.1. System shall provide comprehensive means to access the computer for elevator diagnostic purpose without need for any external devices and shall have permanent indicators to indicate important elevator statuses as an integral part of the controller. Failure of any single magnetically-operated switch, contact or relay to release in the intended manner; or the failure of any static control device, speed measuring circuit, or speed pattern generating circuit to operate as intended; or the occurrence of a single accidental ground or short circuit shall not permit the car to start or run if any hoistway door or gate interlock is unlocked or if any hoistway door or car door or cartop contact is not in the made position. While on cartop inspection or hoistway access operation, failure of any single magnetically-operated switch, contactor or relay to release in the intended manner; or the failure of any static-control device to operate as intended, or the occurrence of a single accidental ground shall not permit the car to move even with the hoistway door locks and car contacts in the closed or made position. Dedicated permanent status indicators shall be provided on the controller to indicate when the safety string is open, when the door locks are open, when the elevator is operating at high speed, when the elevator is on independent service, when the elevator is on fireman's service, when the elevator has failed to successfully complete its intended movement. In addition the means of displaying other special or error conditions that are detected by the microprocessor shall be provided.

2.10.4   Leveling

Leveling system shall utilize a device to establish incremental car position to an accuracy of 0.1875 inches or better using quadrature signal for the entire length of hoistway. Absolute floor number encoding with parity shall be provided at each floor in order to establish exact floor position to the computer. System shall not require movement to a terminal landing for the purpose of finding the correct car position. System shall utilize an automatic 2-way leveling device to control leveling of the car within 1/4 inch above or below landing sill. Over travel, under travel or rope stretch shall be compensated and car brought level to landing sill. Individual car controller shall be capable of learning the position of each floor in building to an accuracy of 0.1875 inches.

2.10.5 Car Controller

The individual car controller shall have software program that uses mathematical methods to create an idealized optimum velocity profile of car travel from any floor to any other floor providing a smooth and stepless elevator ride. System motion parameters such as jerk, acceleration, deceleration rates, etc., shall be field programmable with parametric limitations for the system dynamics and be capable of being stored as non-volatile memory. Drive-control system shall utilize the optimized velocity profile in a dual-loop feedback system based on car position and speed. A velocity feedback device shall permit continuous comparison of car speed with the calculated requirements. A solid-state motor control unit shall be provided for each elevator with electrical characteristics to suit the power supply.

2.10.6 Switches

A switch with static control shall be provided on the governor of all elevators. Switch shall be set at no more than 90 percent of the tripping speed of the governor and shall be activated by overspeed in either direction of travel. Power feed lines to the brake shall be opened by an electromechanical switch and a single ground, or short circuit or solid-state control failure shall not prevent the application of the brake in the intended manner. Systems that do not apply the brake when the car stops at a landing are not acceptable. Isolation transformers or line inductors plus proper filtering shall be provided to eliminate both electrical and audible noise of silicone control rectifier (SCR) drives. A means shall be provided for removing regenerated power from the drive dc power supply. Power shall be dissipated in resistors or returned to the 3 phase ac power line. Failure of the system to remove the regenerated power shall cause drive output to be removed from the hoist motor. A contactor shall be used to disconnect the hoist motor from the output of the drive unit each time the elevator stops. Contactor shall be monitored and the elevator shall not start again if the contactor has not returned to the de-energized position when the elevator stops.

2.10.7 Dispatching

Dispatching through algorithm shall solve the problem of hall-call allocation utilizing the mathematical modeling or queuing theory to optimize elevator service. This sophisticated mathematical solution to elevator dispatching shall perform 3 separate minimization tasks to optimally minimize call waiting time and maximize the system performance. The algorithm shall compile the required physical and statistical data and parameters which are necessary to perform assigned minimization tasks. First minimization algorithm shall assign hall-calls to cars based upon minimizing the average waiting time by calculating the estimated time of arrival (ETA). As traffic becomes busier, minimization of mean waiting time can cause a few hall-call waiting times to get beyond their "long wait hall-call threshold time". At this time the second minimization algorithm shall minimize the "maximum waiting time". As traffic becomes even heavier there will be a tendency to cause too many hall-calls to become late calls thus increasing the total average waiting time. A third algorithm shall minimize the "number of late hall-calls".

2.10.8 Troubleshooting

The microprocessor board shall be equipped with enhanced on-board diagnostics for ease of troubleshooting and field programmability of specific control variables. The microprocessor board shall provide the following minimum features:

a. On-board diagnostic switches and alphanumeric display. Switches and displays shall provide user-friendly interaction with the controller.

b. On-board real time clock. The real time clock shall display the time and date (field adjustable).

c. Display of calls on a per floor basis. All types of calls shall be conveniently entered and/or displayed using on-board switches and buttons.

d. Field programmability of specific timer values (i.e., door times, MG/Scr shutdown time, etc.). The value of these timers may be viewed and/or altered through use of the on-board switches and buttons.

e. Display of the status of all the inputs, outputs and internal control variables and flags listed in order of their English mnemonics.

f. The user shall be able to view and alter the security codes for security operations.

2.10.9   Elevator Control Panel

The panel shall conform to the general requirements for passenger elevator operating and signal fixtures and shall be located in the [_____].

2.10.9.1   Indicator Panel

Indicator panel shall be the cathode ray type capable of displaying the following information:

a. A waiting passenger indicator consisting of a double row of numerals corresponding to floors served by each group of elevators. Each indication shall remain registered until the call has been answered.

b. A position indicator shall be provided for each elevator in the group which will indicate position of each elevator as it passes through hoistway. Elevator position shall be indicated by number corresponding to landing at which the car is stopped or passing. Direction of travel shall be indicated by UP and DOWN indications below each column of position indicators. Position of car shall remain registered when motor drive is not energized.

c. Nonstop indicators numbered to correspond with designated number of elevator which shall indicate when the car is nonstopping or bypassing hall-calls.

d. Indicators shall flash to identify a delayed car condition after a predetermined period of time.

e. Indicators to identify emergency dispatch.

f. Indicators to identify which elevators are on independent service.

2.10.9.2 Control Panel

a. Selection push-buttons [for each elevated] for each group to operate elevators on emergency power and pilot light to indicate emergency power manual select.

b. Key-operated switches to permit selection of individual elevators for independent service. Activation of this key-switch when the elevator is not at [_____] shall permit the elevator to serve all car calls in its present direction of travel and then return nonstop to [first floor] [_____] and remove itself from group operation.

c. A key-operated switch for each elevator with pilot light numbered to correspond with designated number of elevator. Operation of this switch shall take car out of service or place it in service as previously described. Pilot light, when illuminated, shall show which elevators are in an energized condition.

2.11 FREIGHT ELEVATOR CAR

****

NOTE: Specify 6 mm (1/4 inch) plate when Class B or Class C freight loading is provided.

****

Freight elevator car shall have plain steel panel sides [to top of car, fabricated of not less than 12 gauge steel. Panels shall be not more than 36 inches wide] [of 1/4 inch steel plate from the floor to 4 feet above the floor and not less than 14 gauge panels from top of 1/4 inch plate to top of car.] Top of car shall be not less than 14 gauge steel panels with a removable panel for emergency exit. Exit in top of car shall have an electric contact which will prevent operation of elevator when exit is in the open position. Top exit shall be provided with a latch-type lock operable from outside the elevator car and operable with a specially designed tool from within the car.

2.11.1 Car Platform

Car platforms for freight elevators shall be of steel construction with a finish floor of raised-pattern steel floor plate welded or bolted to platform framing members. Bolted platform shall be attached with countersunk flat head bolts. A steel subfloor will not be required if the raised-pattern steel floor plate is of a thickness which will accommodate the capacity of elevator and required type of loading.

2.11.2 Sling

****

NOTE: Maximum speed for Type A instantaneous safety is 0.76 m/second (150 feet per minute).

****

Sling for freight elevator shall be designed for the proper class and loading capacity, constructed of structural or formed steel shapes welded or bolted together, consisting of double channel cross head and bolster with channel uprights, gusset plates and diagonal bracing. Sling shall be provided with [Type A-instantaneous] [Type B-gradual wedge clamp] safety which is activated by an overspeed governor connected to the safety with a governor cable. Sling shall be connected to counterweight frame with steel hoist ropes which run over hoist machine traction sheave. Ropes shall be of a sufficient number to obtain the factor of safety required by ASME A17.1, complete with rope equalizers.

2.11.3 Bumper Guards

Bumper guards for freight elevators shall be fabricated of 6 x 2 inch thick oak mounted on rear and sides of elevator car, beveled back to side walls at entrance columns. Bottom edges of bumper guards shall be 6 inches and 30 inches above floor.

2.11.4 Light Fixtures

****

NOTE: Coordinate with designer and specify number of luxes (footcandles) required to get lighting level in freight car to match lighting level in elevator lobby/building corridors.

****

Lighting fixtures for freight elevators shall be recessed fluorescent type. Fixtures shall be manufactured of sheet steel with flange and enclosed sides and top, shall have a baked-enamel reflector, and shall be mounted directly to outlet box. Bottom of fixtures shall be flush with car ceiling. Fluorescent lighting fixtures shall be dual lamp with quick-starting high-power factor, Class P ballasts with safety lamp guard clamps on fluorescent tubes. Light level shall average at least [_____] footcandles measured at car threshold with doors closed.

2.11.5 Car Emergency Lighting Fixture

[A single unit consisting of a sealed-beam light source, battery and an integral-battery charger, relay and cord and plug connected to a nonswitched standard grounding receptacle shall be provided for freight elevators near the location of the emergency lighting unit.] [Power package as specified for passenger car emergency lighting shall be provided for freight elevators.] Not less than two lamps of equal wattage shall be used to provide a minimum 1.0 footcandle of illumination at a point 4 feet above floor and 1 foot in front of main car operating device for a period of at least 4 hours.

2.11.6 Communications

****

NOTE: Emergency communication in freight elevators is required to an area manned 24 hours per day, or to a central telephone service. Normally use telephone except where vandalism is a problem. Refer to ASME A17.1, Rule 211.1.

****

A telephone system in stainless steel cabinet shall be provided for freight elevators. A vandal-resistant speaker type intercom with push-button to activate shall be installed in car station behind a stainless steel perforated grille and connected to a programmable auto-dialer located in machine room. Auto-dialer shall be provided with a solid-state charger unit which will automatically provide emergency power with an immediate transfer in the event of failure of the normal power supply. The [telephone] [push-button] located in car station or in separate cabinet shall be located at the prescribed handicapped height and shall be identified as "Emergency Phone (Push-to-Activate)." The entire communication assembly shall be approved for an elevator installation. The telephone communication shall not be terminated until one of the communicating parties hangs up the receiver or manually disconnects the communications link.

2.11.7 Freight Signs

Identification signs for freight elevators shall be fabricated of stainless steel and engraved to show the elevator capacity, class of loading and passenger limitations in the format required by ASME A17.1.

2.11.8 Certificate Frame

****

NOTE: Provide and locate where required by local permit and inspection agency.

****

A stainless steel certificate frame with translucent plexiglass lens shall be provided in the size to receive the certificate issued by the inspecting agency. Frame shall be engraved to show name of elevator manufacturer and carrying capacity in pounds.

2.11.9 Car and Counterweight Guide Shoes

****

NOTE: Specify not less than 150 mm (6 inch) diameter rollers for passenger type cars with speeds up to 3.5 m/s (700 feet per minute), and 250 mm (10 inch) diameter rollers for hospital type service elevators and elevators with speeds in excess of 3.5 m/s (700 feet per minute).

****

Roller guides shall consist of minimum 3 tires mounted on top and bottom of car and counterweight frame. Roller guides shall be held in contact with guide rail by adjustable devices and shall run on dry, unlubricated rails.

2.11.10 Car Guide Rails

Guide rails for freight elevators shall be planed steel tee or omega shaped sections with structural channel rail backing as required and tongue-and-groove matched joints reinforced with fitted splice plates. Guide rails shall extend from bottom of pit to underside of roof over the hoistway.

2.12 FREIGHT ELEVATOR ENTRANCES

2.12.1 Hoistway Frames

Hoistway frames for freight elevators shall be designed and fabricated as part of a Class B 1-1/2-hour fire-rated door/frame assembly to meet requirements of NFPA 252, and shall bear the label of an approved testing laboratory. For installation in gypsum board walls hoistway frames shall be 14 gauge [carbon sheet-steel] [carbon sheet-steel with stainless steel cladding]. Head and jamb section shall be bolted assembly with bolts, washer and locking nut or lock washer. Frame assembly shall be securely fastened to structure. Frames shall return to wall. For installation in concrete walls knock-down type hoistway frames may be used.

2.12.2 Hoistway Doors

****

NOTE: Specify 0.5512 mm thick (26 gauge) galvanized sheet steel doors with wood core when sound deadening is required. Vestibules should be provided to protect exterior opening panels from the weather.

****

Hoistway doors for freight elevators shall be designed and fabricated as part of a Class B 1-1/2-Hour fire-rated door/frame assembly to meet requirements of NFPA 252 and shall bear the label of an approved testing laboratory. Door panels shall be [vertical bi-parting] [pass-type] counterbalanced, power-operated which shall consist of 2 sections designed to balance each other and move simultaneously. Door panel construction shall be [12 gauge sheet steel with formed edges and vertical reinforcing back ribs spaced 18 inches on center] [26 gauge galvanized sheet steel with visible vertical seams cladded to a laminated wood core]. Each door shall be reinforced on the periphery with a frame of built-up steel angles or other suitable sections not less than 3/16 inch thick for mounting the necessary guide shoes and chain-suspension system. Door panels shall be securely bolted, riveted or welded into the door panel frames. [Exposed steel shall be finished with rust-inhibitive primer and baked-enamel in a color to be selected, unless otherwise specified.] [Exposed stainless steel shall be finished with No. 4 Satin Finish, unless otherwise specified.]

2.12.2.1 Upper Door Panel

Upper panel of each freight elevator hoistway door shall be equipped with a clear wire glass vision panel placed on side closer to car operating station. Vision panel shall be sized as required by ASME A17.1. Bottom edge of panel will be provided with a fire-resistant approved safety astragal which shall be nonshearing and noncrushing and will not damage foreign objects 3/4 inch or less when door is in the closed position. Rubber bumpers shall be provided on lower edge of panel near each jamb mounted to provide safety action specified. Rubber bumpers and safety astragals shall be designed for easy replacement.

2.12.2.2 Lower Door Panel

Lower panel of each freight elevator door shall be provided with a 1/2 inch thick steel toe guard beveled toward hoistway wall at a 60 degree angle to the horizontal. Upper edge of lower door panel shall be equipped with a truckable steel sill designed to be level with landing when doors are in the fully-open position. Truckable sills shall be of sufficient size and adequate strength to bridge the space between building sill and car platform and to support a trucking load equal to the rated capacity of elevator car. Truckable sill shall extend the full width of door opening and shall be supported by stationary adjustable stops fastened to each door guide rail. Shearing hazard shall not exist on bottom door panel during the door opening operation.

2.12.2.3 Door Guide Rails

Guide rails for freight elevator hoistway doors shall consist of suitable structural shapes for each door section securely fastened to door frame and hoistway construction. Guide rails shall be designed and fabricated in accurate alignment so that door guide shoes will operate freely upon rails. Each door frame shall be equipped with four fixed or adjustable steel or malleable-iron grooved shoes of proper depth and vertical side contact on each side of rail. Shoes shall be attached to vertical structural door frame members and shall be spaced the maximum possible distance apart. Shoes shall be constructed to relieve door and guide shoe supporting members of all frictional contact with guide rails.

2.12.2.4 Door Interlocks

Hoistway doors for freight elevators shall be equipped with a tamper-proof interlock system which shall prevent operation of car until doors are locked in the closed position as defined by ASME A17.1. Interlocks shall lock the two door sections together to prevent doors from opening at corridor side unless car is at rest at landing or is traveling through the leveling zone or the hoistway access switch is used. Retiring cams for hoistway door interlocks shall be provided and securely fastened to supports on car enclosure.

2.12.2.5 Door Unlocking Device

Hoistway doors for freight elevators shall be complete with unlocking devices as described in ASME A17.1 and shall be provided at all floors. Parking device shall be located at a floor selected by Contracting Officer.

2.12.3 Car Gates

Car gates shall be provided at each freight elevator entrance to protect the entire width of opening to a height of 6 feet above sill. Car gates shall be heavy-duty [pass type] [vertical-sliding type constructed of minimum 10 gauge wire mesh or flat-expanded metal attached to steel angle frame with hardware and accessories as required.] Car gates shall be equipped with weights for closing or balancing the gates. The guide shoes shall be designed to run on vertical tracks rigidly fastened to car enclosure. When fully raised the bottom edge of gates shall not protrude into clear opening of hoistway entrance. Lower edge of gate panel shall be equipped with a safety edge to stop the downward motion of gate when gates encounter an obstruction. Car gates shall be pass-type 2-speed power operated if there is insufficient clearance available when the elevator is at the top floor. Pass-type car gates shall be provided in conjunction with pass-type hoistway doors.

2.13 FREIGHT ELEVATOR DOOR AND CAR GATE OPERATION

****

NOTE: Select either automatic open and close, or automatic open with continuous pressure close. Specify full-selective door operations for power-operated hoistway doors when two openings occur at the same floor.

****

Each hoistway door and car gate for freight elevators shall be equipped with an individual electric operator. Operators shall open and close car gate and hoistway doors at a panel speed of not less than one foot per second without slamming. Limit switches shall be provided to stop the motors as doors approach their limit of travel. Provisions shall be made for manual operation of the doors from inside the car in the event of power failure. Door operators shall be arranged to open doors automatically after the car enters the automatic leveling zone at the designated landing. "Open" and "Close" operating buttons and any additional devices required shall be provided in car and at each hoistway entrance. Constant pressure on the "close button" shall close the door. Momentary pressure on the "open button" shall reopen the door provided the car is at a landing. Electric operators shall be of the highest quality and quiet in operation and shall be provided with all parts designed and constructed to meet the severe requirements of electrical service. Gates shall be provided with reversing edge and passenger sequence operation. Car doors shall be equipped with an infrared proximity-type car door protective device having the following operation:

a. When doors are in the full-open position, doors shall be unable to initiate closing if a passenger comes within the detection zone. The detection zone moves with doors, so that if a passenger or object enters the zone after doors have begun to close, doors shall stop and then reverse to reopen. Doors shall reclose after a brief time. A passenger entering or leaving car shall not cause doors to reopen unless doors reach a predetermined proximity to passenger.

b. After a stop is made, doors shall remain open for a time to permit passenger transfer after which the doors shall close automatically. This time interval shall be less for a car call than for a hall call or a coincident car/hall call.

c. If there is either a hall call anywhere in the group or a car call in the car in question and the doors are prevented from closing for a fixed period, the door protective device shall be rendered inoperative, a buzzer shall sound in the car and the doors shall close at approximately half speed. Normal door operation shall resume at the next landing reached by car.

2.14 FREIGHT ELEVATOR OPERATING AND SIGNAL FIXTURES

****

NOTE: If elevator is combination passenger and freight FED-STD 795 and 36 CFR 1191 will apply.

****

Operating and signal fixtures for freight elevators shall conform to the general requirements for passenger elevator operating and signal fixtures, with the exception that complying with FED-STD 795 and 36 CFR 1191 is not required.

2.14.1 Car Operating Panel

Operating panel in freight elevators shall consist of a recess-mounted panel near car gate containing the following operating devices:

a. Emergency stop switch (pull to activate), when operated, will stop the car independently of the normal operating devices and sounds the emergency signal bell.

b. Key-operated car light/fan switch.

c. Emergency signal button connected to a 6 inch diameter signal bell outside elevator hoistway at [first floor] [_____] located as shown or as directed.

d. Communication [speaker phone, grille and push-to-talk button] [telephone].

e. Key-operated inspection switch which will render normal operating devices inoperative for purpose of using hoistway access switches.

f. Key-operated fire-service switch and light jewel.

g. [Continuous] [Momentary] pressure "DOOR CLOSE" button and momentary pressure "DOOR OPEN" push button for power-operated doors.

2.14.2 In-Car Position Indicator

In-car position indicator in freight elevators shall consist of engraved black-filled numerals not less than 1 inch high, and 3/8 inch diameter vandal-resistant light jewels directly beneath each number. As car travels through hoistway the car position shall be indicated by illumination of light jewel corresponding to landing at which the car is stopped or passing. Necessary light baffles shall be provided.

2.14.3 Car Push-Buttons

Car push-buttons in freight elevators shall be numbered to correspond to landings served. Faceplates shall be provided with raised indicators to the right of floor buttons. Buttons shall be encased with metal and embossed to permit illumination when a call is registered. Buttons for car and hall operating stations shall be designed to seat on faceplate in lieu of button mechanism with 1/32 inch operating clearance. Buttons shall have maximum protrusion of 3/16 inch beyond faceplate with beveled edges to prevent damage from side blows.

2.14.4 Hall-Call Station

Operating devices for freight elevators at each landing shall consist of a recess-mounted momentary pressure car call-button [and momentary pressure "DOOR OPEN"] [and continuous pressure "DOOR CLOSE"] buttons.

2.14.4.1 "IN USE" Light

****
NOTE: "IN USE" light is used only when manually-operated freight elevator doors are used.
****

A red jewel "IN USE" light shall be illuminated when freight elevator is in motion and also when car is standing at any floor with hoistway door opened or car gate opened.

2.14.4.2   Fire Recall Key

Fire Recall key-switch for freight elevators shall be located at the designated landing faceplate.

2.14.4.3   Hoistway Access Switches

Hoistway access switches for freight elevators shall be located in lower and upper terminal floor hall stations.

2.15   FREIGHT ELEVATOR OPERATION

2.15.1   General

When freight elevators are not in use and the door-locking circuit is established, the momentary pressing of a landing call-button shall bring the car to that landing. Momentary pressing of a car dispatching button in car panel shall send the car to designated landing if car gate and hoistway doors are closed and the door-locking circuit is established.

2.15.2   Car Operation

Freight elevators shall operate as an automatic [2-stop collective] [simplex] [duplex] [selective/collective] as described for passenger elevator. A nonstop button in car station shall be provided.

2.15.3   Service-Demand Bell

A service-demand bell shall be provided in freight elevator which will sound when a landing button is pressed while a door is in the open position.

2.15.4   Inspection and Maintenance Switch

An inspection and maintenance switch for freight elevator shall be mounted in car-control panel to disconnect the landing buttons. When the switch is closed the car may be operated by continuous pressure on UP and DOWN buttons on top of car which will operate the car at a reduced speed.

2.16   AUTOMATIC EMERGENCY POWER OPERATION

Elevator control system shall be arranged to operate on emergency power supply upon failure of the normal power supply. Elevators operating on dedicated service, such as [hospital service] [and] [fire service], will not be required to return to the designated landing when emergency power becomes available for respective elevator. Elevators shall operate as follows:

a. When normal power supply fails, all cars shall shut down.

b. One car shall automatically start and travel at full-rated speed to the designated landing stop, open the car and hoistway doors and then shut down.

c. After first car shuts down, other cars in the group shall individually operate as described above.

d. After all cars have moved to the designated landing a preselected car shall operate at rated speed to serve car and landing calls. Automatic selection can be overridden manually. Emergency power selector buttons and light jewels shall be provided in a stainless steel faceplate at the designated landing. Emergency power selector buttons shall be operable after automatic return has been completed, and shall permit the selection of a maximum of [one] [_____] elevator at a time.

2.17 AUTOMATIC ELEVATOR OPERATION

2.17.1 General

The operating device shall consist of a series of push-buttons in car numbered to correspond to various landings, "UP" and "DOWN" buttons at intermediate landings, and a single button at terminal landing. To meet the elevator operation requirements specified in this section, all buttons shall be connected electrically to the control system which governs the floor selection, car selection, direction of travel and governs the acceleration and retardation.

2.17.2 Operation

Car calls shall be registered within the car by pressing the button corresponding to the designated floors. Hall calls shall be registered by pressing buttons in the corridor push-button fixture. Once the demand for elevator service has been established and the car has received a start signal the car operation shall be as follows.

2.17.2.1 Door Closing

Doors shall close automatically. When doors are fully closed and the interlock circuit established, the car shall start to move in the direction established by control system. Car shall accelerate and decelerate automatically and stop at [first floor] [_____] for which a car button has been registered or at the [first floor] [_____] for a corridor demand which has been assigned to car. Car shall stop at all floors for which car calls are registered in the order in which the floors are reached and shall stop for any corridor demands assigned to the cars in the order in which the floors are reached.

2.17.2.2 Door Opening

Doors shall open automatically as car reaches the landing. After a predetermined time the doors shall close and the car shall proceed to answer the remaining car or assigned corridor calls. A protective device such as a safety edge and light beam device shall be provided on car door and when activated will prevent closing of doors. Cars shall become available for assignment at whatever floor the last car demand has been satisfied in the direction in which car is traveling.

2.17.2.3 Car Dispatch

When car does not receive a demand dispatch at dispatching floor for an adjustable time period up to 10 minutes set initially at 5 minutes, the motor drive unit shall be switched off. If the car's switched-off motor drive unit receives a demand dispatch the motor drive unit shall automatically restart.

2.17.2.4 Door Dwell-Time

Door open dwell-times shall be adjustable so that the open time for a car call is shorter than the open time for corridor calls and second passengers. If a longer time is needed for passenger entry, doors can be prevented from closing or reversing by the light beam door control, the protective leading edge on car door, or by pressing "DOOR OPEN" button in car. Door dwell-times shall comply with FED-STD 795 and 36 CFR 1191.

2.17.3 Independent Service

****
NOTE: Provide only if two cars or more.
****

Freight elevators shall be arranged for independent service operation with a key-switch located in the locked section of car operating panel. When the car key-switch is placed in the "ON" position the key-switch shall remove car from corridor button operation to permit operation from car-buttons only. Elevator direction lanterns shall be inoperative when elevator is in this mode of operation.

2.17.4 Automatic Load Weighing

Passenger elevators shall be provided with load-weighing devices which will cause elevator to bypass hall calls when elevator is filled to an adjustable percentage. Corridor calls shall remain registered until the next available car responds to the call.

2.17.5 Anti-Nuisance

Passenger elevators shall be provided with a system which will cancel all car calls in the event that between 3 and 5 times the number of car calls are registered as there are passengers in car, allowing 150 pounds per passenger.

2.17.6 Door Operation

Double-door operation shall not be permitted for passenger elevators. If an UP traveling car has a passenger for an intermediate floor and a DOWN call is registered at that floor with no-calls above car, the car shall travel to floor, open the door and let passenger out, then light the DOWN direction arrow in hall lantern and accept the waiting passenger who registered the DOWN call. Doors shall not perform the open-close cycle before elevator proceeds to next call.

2.17.7 Automatic Power Shutdown Upon Fire Sprinkler Activation

****
NOTE: Delete this paragraph if the elevator machine room or the hoistways are not provided with automatic fire sprinklers. The designer may modify paragraph to use established local or state codes for automatic power shutdown in lieu of the procedures listed below, if approved by the installation.

1. In buildings required to be sprinklered, elevator machine rooms and hoistways will be sprinklered as required by NFPA 13. In the hoistways, sprinkler heads may required at the top

and near the bottom of the hoistway.

2. Automatic power shutdown will be accomplished by activation of dedicated sprinkler waterflow switch(es) which only supervise the sprinklers located in the hoistway and in the elevator machine room. A waterflow switch, O.S.& Y. valve and check valve assembly will be provided for elevator sprinklers. Each hoistway enclosure shall be separately zoned for power shutdown. Waterflow switches and valves will be located outside of and adjacent to the elevator machine room and hoistway(s). Control valves will be readily accessible. An inspector's test connection with outside discharge will be provided for each waterflow switch. Sprinklers will be standard sprinklers with intermediate temperature rating. The waterflow switch(es) will be connected to a shunt trip breaker or other suitable device to shutdown power to the affected elevator(s).

3. A heat detector will be provided adjacent to each sprinkler located in the elevator machine room and in the hoistway. Activation of the heat detector will send the elevator cab to the nearest floor away from the fire. Heat detectors will be zoned to direct elevator cab to safe landing prior to power shutdown by the sprinkler waterflow switch..

4. The designer will indicate all switches, valves, sprinklers, piping, inspector's test connections, detectors, electrical equipment and wiring needed to achieve automatic shutdown.
****

Automatic power shutdown of the elevators will be initiated by a waterflow switch supervising sprinklers located in the elevator machine room or in the elevator hoistway. Provide heat detectors which are fixed-temperature-rate-of-rise, rated at 135 to 140 degrees F adjacent to each sprinkler head in the hoistway(s) and in the machine room. Heat detectors shall be connected to the elevator control system which shall cause the following to the affected elevator(s), upon activation of the heat detector.

a. Elevators which are in motion will proceed to the nearest available landing away from the fire floor, and shall cause power-operated doors to open and remain open until manually reset. The fire floor is considered the floor where the heat detector is located.

b. Elevators which are standing at a landing with open doors will remain open at the floor. If power-operated doors are closed, the elevator will cause the doors to open.

2.18 HOSPITAL EMERGENCY SERVICE OPERATION

****
NOTE: Specify for hospital or other institutional type facility when immediate access to elevators is mandatory for emergency purposes. Indicate which elevator requires this. Delete if not required.
****

2.18.1 General

Provisions shall be made for calling elevators [_____] to any floor on an emergency basis which are operating independently from dispatch signals and landing call signals.

2.18.2 Key-Switches

Landing key-switch shall be spring-return momentary-contact type installed [in floor landing push-button fixture box above push-buttons] [at a remote location] at [all] [_____] floors. Car hospital emergency key-switches shall be two-position ON-OFF type located in the upper section of car operating panel for elevator numbers [_____]. All key-switches shall be provided with an appropriately engraved call-registered light jewel. Keys shall be removable in the off-position only. Landing key-switch and hospital emergency key-switch in car shall be keyed the same for all elevators in building and shall not be operable with any other key which will operate any other lock or device used for any other hospital purpose. Keys shall be provided for each type of cylinder furnished.

2.18.3 Operation of Assigned Elevator Response

When switch is activated at any floor the call-register light jewel at respective floor shall illuminate and the elevator group dispatching system shall immediately assign an elevator in group service with the shortest response time to hospital emergency call. Immediately upon assignment registered car calls within the respective elevator shall be canceled. Landing calls previously assigned to selected elevator shall be transferred to another elevator. If the assigned elevator is traveling away from the hospital emergency call the car shall slow down and stop at the nearest floor, and without opening the car doors, the car shall reverse direction and proceed nonstop to hospital emergency call floor. If the assigned elevator is traveling toward hospital emergency call floor, the car shall proceed to the assigned floor nonstop unless the car is slowing down for a stop, where the elevator shall stop without opening car doors and immediately start toward the hospital emergency call floor. Should all cars be unavailable to respond to the landing call the register light shall not illuminate. Upon arrival at hospital emergency floor the elevator shall remain with doors open for an adjustable dwell-time interval in the range of 10 to 60 seconds initially set at 30 seconds. After this interval has expired the car shall automatically return to normal service if the car has not been placed on hospital emergency operation from within the car. Any elevator selected to respond to a hospital emergency call shall be removed from group service and shall not accept additional calls, emergency or otherwise, until the car has completed the total hospital emergency function. Any car operating in group service may be selected. Additional hospital emergency calls that are registered in the system shall cause additional cars to respond as described above, always on the basis of one hospital emergency call per car.

2.18.4 In-Car Operation

Activation of the in-car hospital emergency key-switch shall override dwell-time and permit the assigned elevator to accept a car call for any floor, automatically close the doors and proceed nonstop to the selected floor. Elevator shall remain disconnected from group hall-button riser during this operation. The return of key-switch to normal position shall extinguish the call-register light and restore elevator to normal service.

2.18.5 Signals

Top section of each car operating panel and in the center of rear cab panel (approximately 6 feet 0 inches above floor) the backlighted "HOSPITAL EMERGENCY" indicators shall be provided to flash on-and-off continuously when car is assigned to this operation until restored to normal service. "HOSPITAL EMERGENCY" indications shall be a photographic negative type with l/4 inch high letters which are legible only when illuminated.

2.18.6 Graphics

Exposed position of each switch faceplate shall have legible indelible legends engraved or etched to indicate its identity and positions. All letters in faceplate shall be not less than l/4 inch high and filled with black or red paint.

2.19 FIREFIGHTERS' SERVICE

****
NOTE: Reference Section 13850 and/or 13851, dealing with Fire Detection and Alarm System, only to specify the smoke detectors if the detectors are to be provided by the Alarm Contractor; however, they should not specify the firefighter service.
****

Firefighter service shall be in accordance with ASME A17.1 for automatic elevators. Elevator lobby and machine room smoke detectors shall be [photoelectric] [ionization] spot-type smoke detectors. Smoke detectors shall be powered from to the building fire alarm control panel. Elevator lobby and machine room smoke detectors shall be in accordance with Section [13850 FIRE DETECTION AND ALARM SYSTEM, DIRECT CURRENT LOOP.] [13851 FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE.]

2.20 ELEVATOR MACHINE (GEARED)

****
NOTE: Specify geared elevators for speeds up to 2 m/s (400 feet per minute) and gearless for speeds greater than 2 m/s (400 feet per minute). Gearless elevators are located in paragraph ELEVATOR MACHINE (GEARLESS).
****

2.20.1 Hoisting Machine

Machine shall be worm-geared traction type with motor, brake, worm gearing, traction sheave and bearings mounted on common bed plate. Worm shall be of steel and integral with the worm shaft and shall be provided with a ball-thrust bearing with self-alignment blocks or preloaded thrust bearing designed to take the end thrust of the worm in both directions. Main gear shall be hobbed from a bronze rim accurately fitted and bolted to gear spider. Gears shall be fitted to minimize the noise, vibration and wear. Roller bearings shall be complete with drive sheave shaft and provisions for lubrication. Design and construction of equipment and parts subject to wear shall be completely repairable and replaceable.

2.20.2 Hoisting Ropes

Hoisting ropes shall be the independent wire-rope type, regular lay, preformed, non-coated, improved plow steel of 6 x 37 construction. Hoisting ropes shall be suited for service requirements to be provided. Hoisting rope connections shall be by tapered babbitted socket connections and shall be rated in strength equal to or greater than the strength rating of the rope. Hoisting ropes shall be selected so that the rated capacity load plus the load block weight divided by the number of parts of rope will not exceed 20 percent of certified breaking strength of rope. Hoisting ropes shall be secured to the hoist drum so that no less than two wraps of rope remain at each anchorage of hoist drum at extreme low position.

2.20.3 Sheaves

Drive sheave shall be steel or semi-steel finished with grooves to receive hoist ropes and shall give maximum traction and minimum wear. Grooved nonmetallic inserts on drive sheave may be provided at Contractor's option. Deflector and overhead sheaves, suitable sheet metal guards with required service openings, sheave beams and supports shall be provided as required.

2.20.4 Hoist Motor (Geared)

Motor shall be a geared type, [direct-current for variable voltage with Class B insulation,] [alternating-current for rheostatic control with Class F insulation,] designed for elevator service to develop the required high-starting torque with low-starting current in accordance with NEMA MG 1. Motor shall be designed to meet requirements of elevator service and be capable of starting cold and carrying the full-rated load in car for a period of 1 hour of continuous UP and DOWN runs, stopping at all floors and standing not more than 10 seconds at each floor without overheating. Speed regulation of the car, with full-rated load shall not exceed plus or minus 5 percent of average on a round trip.

2.20.5 Armature

Armature shall be electrically balanced and the armature and brake drum shall be mechanically balanced as a unit. Field coils shall be spool or form wound. Windings in both armature and field shall permit easy removal.

2.20.6 Commutator

Commutator and brushes shall be of sufficient size, area and designed to perform under full-load with sparks barely visible and without overheating. Brushes shall have individual tension adjustment with provisions for adjusting and positively locking the brush holder in place as a unit.

2.20.7 Brake Assembly

Brake shall be spring-applied, electrically released and designed for automatic application in the event of interruption of power supply. Brake drum shall have a wearing surface and edge of flange turned smooth and wearing surface shall run within a maximum variation of 0.005 inches.

Brake shoes shall be lined with a fireproof friction material shaped to shoes so that the drum will run free with normal clearance. Brake springs shall be helical and operated in compression and shall apply the brake when released by the magnet. Brake magnet shall be designed to release quickly. The brake application shall be automatically controlled by magnetic retardation to obtain noiseless, smooth and gradual stops under all loading conditions. Release magnet coil circuit shall be opened by the various safety devices, power failure, failure of equipment to function in the proper manner for safe operation of car and upon normal stopping of the car.

2.20.8 Bed Plate

Bed plate shall be cast iron or steel in one piece with stiffening ribs to accurately maintain alignment of parts or be heavy rigid structural steel shapes securely welded together. Pads accurately planed or milled shall be provided as seats for parts secured to bed plate.

2.21 ELEVATOR MACHINE (GEARLESS)

****

NOTE: Specify geared elevators for speeds up to 2 m/s (400 feet per minute) and gearless elevators for speeds greater than 2 m/s (400 feet per minute). Geared elevators are specified in paragraph ELEVATOR MACHINE (GEARED).

****

2.21.1 Hoisting Machine

Hoisting machine shall be of gearless type consisting of a motor, traction sheave and brake compactly grouped on a single shaft supported by two bearings rigidly mounted. Design and construction of equipment and parts subject to wear shall be completely repairable and replaceable.

2.21.2 Shafts

Shafts shall be forged steel or bar stock with tensile strength not less than 60,000 psi manufactured true to size. Bearing mounting and the method of machining and assembly shall provide accurate bearing alignment. Bolts shall be wrought or mild steel with a tensile strength of not less than 50,000 psi.

2.21.3 Sheaves

Sheaves, including governor sheave, shall be turned and grooved and flanges shall run true and be free from cracks, sand holes or other imperfections which might injure the cable. Traction hoisting sheave shall be hard cast iron or semi-steel suitably grooved to produce proper traction and shall be thick enough to provide future wear in grooves. Sheaves shall be of the proper diameter for cables used. Deflector sheaves, when used, shall be similar to traction sheaves with semi-circular grooves at bottom to provide a smooth bed for cables. Nonmetallic groove inserts on drive sheave may be provided at Contractor's option. Deflector sheave, if used, shall be securely mounted below machine beams in proper alignment with traction sheave and with bearings as specified in this section for hoisting machine shaft. Where deflector sheaves are used, wire screen guards and drip pans fabricated of 26 gauge galvanized steel under bearings shall be provided. Fastenings for removal of drip pans shall be of type which can be easily removed.

2.21.4 Bearings

Shaft bearings shall be anti-friction bearing metal, ball or roller-bearing type. Bearings shall be rigidly fastened to main structure of bed plate and shall be self-aligning or machined integral with the base to assure positive alignment. Anti-friction bearings shall be of ample size for loads imposed and shall be provided with oil reservoirs, automatic oil feed lubrication, oil gauges and an approved means of draining and flushing bearings. Bearing pressures shall not exceed 400 psi for babbitt and 600 psi for bronze. Outer ends of bearings shall be closed with a suitable oil-tight cap or plate. Inner ends of bearings shall be provided with oil wipers or shaft shall be flanged to prevent oil leakage. Ball and roller bearings shall be provided with provisions for greasing, except for the roller bearings which are immersed in an oil bath or are oil lubricated by splash or positive feed.

2.21.5 Bed Plate

Bed plate shall be cast-iron or steel fabricated in one piece with stiffening ribs to accurately maintain the alignment of parts or bed plates can be heavy rigid structural steel shapes securely welded together. Pads accurately planed or milled must be provided as seats for parts secured to bed plate.

2.21.6 Hoist Motor (Gearless)

Motor shall be a gearless type, direct-current for variable voltage with Class B insulation, designed for elevator service to develop the required high-starting torque with low-starting current in accordance with NEMA MG 1. Motor shall be capable of carrying full-rated load in car for a period of one hour continuous run, starting cold, stopping at all floors, UP and DOWN and standing not more than 10 seconds at each floor. At the end of the run, the temperature rise of insulated winding shall not exceed 50 degrees C ambient. Commutator shall not exceed 55 degrees C rise. Motor shall provide continuous regular elevator service of not less than 140 actual floor stops per hour with the insulated windings not to exceed 50 degrees C ambient temperature rise. Speed regulation of car with full-rated load shall not exceed plus or minus 5 percent of the average round trip speed. Acceleration under full-load, UP and DOWN shall be not less than 5 feet per second per second and not over 6 feet per second per second, measured from start of car motion to the time of attaining 80 percent of full-rated speed. Acceleration control shall be adjustable. Motor shall run in either direction under full-load with only normal heating and with minimum amount of sparking with the same brush setting for all loads and speeds within the capacity range.

2.21.7 Armature

Armature shall be electrically balanced and the armature and brake drum shall be mechanically balanced as a unit. Field coils shall be spool or form wound. Windings in both armature and field shall permit easy removal.

2.21.8 Commutator

Commutator and brushes shall be of sufficient size and area, and shall be designed to perform under full-load with sparks barely visible and without overheating. Brushes shall have individual tension adjustment with provisions for adjusting and positively locking the brush holder in place as a unit.

2.21.9 Brake Assembly

Brake shall be electro-mechanical consisting of a brake drum cast integral with traction sheave, shall have two or more brake shoes suitably secured to machine bed, shall have springs to apply the brake and shall consist of a direct-current electro-magnet to release the brake. Brake drum shoes and springs shall be of sufficient size and strength to stop and hold the car when carrying the maximum load. Shoes shall be lined with a fireproof friction material shaped to shoes so that the drum will run free. Brake springs shall apply brake when released by magnet. Brake magnet shall be designed so that the release is smooth, quick and complete. Release magnet coil circuit shall be opened by the safety devices, power failure, or the failure of equipment to function. Wearing surface shall run within a maximum variation of 0.005 inch.

2.22 SOUND AND VIBRATION ISOLATION

Sound and vibration isolating foundation shall effectively prevent the transmission of machine vibration and sound to building structure. Location and deflection characteristics of isolation units shall produce a uniform and nonexcessive loading on units under all operating conditions.

2.23 AC RHEOSTATIC CONTROL

****

NOTE: Rheostatic ac control should be specified for intermittent operation light-duty low-rise passenger or freight elevators with a maximum speed of 0.75 m/s (150 feet per minute).

****

2.23.1 General

Hoisting machine motor shall conform to NEMA MG 1, for alternating current, 2-speed (4 to 1 ratio) Class AH3, reversible induction type motor, either tandem slip-ring squirrel cage or double-wound stator squirrel cage type having Class A insulation and a 30-minute rating. Motor shall be designed for elevator service. Capacity shall be adequate for operation of elevator at rated-load and speed for 30 minutes without overheating. Ratio of high speed to low speed shall be 4 to 1 and shall provide car operation at no more than 25 fpm at low speed.

2.23.2 Windings

Insulation of all windings shall be impregnated and baked to prevent the absorption of moisture and oil.

2.23.3 Bearings

Motor bearings shall be either anti-friction bearing metal sleeve type with oil reservoirs, automatic self-lubrication, oil gauges, capped filler openings and drains, or motor bearings shall be ball or roller type arranged for grease lubrication and fitted with grease-gun connections and drain plugs. Bearings and lubricant reservoirs shall be dust tight and shall incorporate effective lubricant seals or other means to prevent lubricant leakage.

2.24 VARIABLE VOLTAGE CONTROL

2.24.1 Performance

Control system shall govern the starting, stopping and direction of travel of elevator and provide the operation specified. Control shall be accomplished by an individual generator or solid-state motor control for each elevator where the voltage applied to hoist motor is variable. Control equipment shall be of type suitable for motors and type of operation specified to provide smooth acceleration from stop to full speed, deceleration and landing stops under any load condition from no load to full-rated load. Smooth operation shall be obtained under stable conditions which provide for a maximum time of [_____] seconds from start of car motion to floor level at the next floor for gearless elevators. Maximum time from start of car motion to floor level at the next floor for geared machines shall be [_____] seconds for a speed of 350 feet per minute. Time from door close to start of car motion shall not exceed 0.7 second with a balanced load. Cycle time, which is the time from start of door close to door fully open at the next typical floor, shall not exceed [_____] seconds, with a maximum premature door opening of 3 inches from the floor for all gearless elevators, [_____] seconds for geared elevators with a speed of 350 feet per minute. Prior to the termination of maintenance period included in the Base Contract, elevators shall be readjusted as required to meet performance requirements. All performance times specified in this section are based on [_____] feet [_____] inches floor height, and [_____] feet [_____] inches wide [center-opening] [two-speed slide] [single-speed slide] doors.

2.24.2 Controller

Electric controller shall be microprocessor-based logic type with battery backup system with charger and charge time for a depleted battery, battery reserve and a low-voltage disconnect. Components required for proper performance of elevator shall be neatly mounted and wired and completely enclosed in a cabinet with a mechanically-latched door.

2.24.3 Motor Generator Set

****

NOTE: Select the following "Motor Generator Set" or "Solid-State Motor Control". Do not specify both.

****

Elevator control shall be effected by means of a uniformly varying dc voltage applied to elevator motor. An individual motor generator set shall be provided for each elevator.

2.24.3.1 Vibration Isolators

Generator set shall be located in elevator machine room and provided with a vibration-isolated foundation or a vibration-absorbing device which shall be effective in preventing the transmission of vibration to building structure.

2.24.3.2 Mounting

Motor generator shall be compact in design with all units mounted on same rigid cast iron or structural steel bed plate. Motor and generator units shall be mounted on a single rigid steel shaft.

2.24.3.3   Start Sequence

Motor generator set shall start automatically by registration of a car or landing call and shall stop automatically in a predetermined time adjustable from 1 to 12 minutes after all calls have been answered. Motor generators shall be arranged for sequence starting to prevent more than one motor generator from starting simultaneously.

2.24.3.4   Duty Rating

Design of apparatus shall be in accordance with the NEMA MG 1 specifications for 50 degrees C temperature rise, continuous-duty rating and IEEE Std 304 rules for Class A insulation and 50 degrees C continuous operation.

2.24.3.5   AC Contacts

Main ac contacts on starting panel shall be copper to carbon. Contacts breaking the main ac line current shall be provided with magnetic blow-outs.

2.24.3.6   Commutator

Sparks from the commutator shall be barely visible when elevator is accelerating or retarding from full-speed with a load in car ranging from no-load to full-load.

2.24.3.7   No-Load Speed

The no-load synchronous speed of motor generator set shall not exceed 1800 rpm. Proper direction of rotation shall be indicated by an arrow on frame.

2.24.3.8   Bearing Lubrication

Bearings shall be anti-friction bearing metal type with oil reservoirs, automatic self-lubrication and gauges, or of the ball-bearing type arranged for grease lubrication and fitted with grease connections.

2.24.3.9   Automatic Remote Control Starting Panel

Automatic remote control starting panel shall contain the necessary switches and overload devices. Starter may be separate or be incorporated in controller.

2.24.4   Solid-State Motor-Control

A solid-state motor-control unit shall be provided for each elevator, with electrical characteristics suitable to the available distribution system. The system shall consist of necessary 3-phase, full-wave bridge rectifiers or other devices and shall be full regenerative. A Transient Voltage Surge Suppressor (TVSS) device shall be provided to protect the solid-state motor-control unit and other electronic equipment in the facility. Solid-State control unit shall have the capacity to handle peak currents and shall contain a balanced and coordinated fault-protection system to protect the unit as follows:

a. Protection system shall protect complete power circuit (specifically the power semi-conductors) from failure under short circuit conditions.

b. Protection system shall protect unit from faults arising from partial grounds, partial shorts in motor armature, or in power unit.

c. Protection system shall protect drive motor against sustained overloads using a solid-state overload circuit.

d. Protection system shall protect motor and power unit against instantaneous peak overload.

e. Protection system shall protect phase sequence to ensure incoming line is phased properly.

f. Protection system shall protect unit against instantaneous overcurrent.

g. Protection system shall protect unit against low power line voltage (less than 75 percent of nominal).

h. Protection system shall protect unit against blown ac input fuse and blown dc converter output fuses.

i. Protection system shall protect against excessive converter output voltage and excessive open-circuit voltage, and heat dissipation device.

j. The Transient Voltage Surge Suppressor (TVSS) device used to protect the solid-state motor-control unit shall be listed by UL 1449 and tested by manufacturer to meet requirements of IEEE C62.11, IEEE C62.41 and IEEE C62.45 Categories A, B and C. The system shall be connected in parallel with the protected system; series-connected elements which could constitute a single-point failure shall not be used. The protection modes for the TVSS device shall have as a minimum line-to-ground, neutral-to-ground, line-to-neutral and Delta Systems line-to-line. The TVSS surge current capacity, based on an 8 x 20 micro-second waveform, shall be a minimum of 75K amps per phase. The maximum UL 1449 clamping voltage for each protection mode shall not exceed 800 volts for 208, 240 and 277/480 volt system. The TVSS system shall provide a joule rating that meets or exceeds the requirements of IEEE C62.41 Category C delivery capability. The TVSS system shall provide a noise-attenuation of 40 db for electrical line noise. The TVSS system shall be a symmetrically balanced metal oxide varistor (MOV) array system, constructed with surge current diversion modules each capable of withstanding 25 KVA surge current based on standard 8 x 20 micro-second waveform. Each module shall be capable of withstanding over 1000 pulses of 10K amps in accordance with IEEE C62.41 Category C surge current without degradation of clamping voltage. The module shall consist of multiple gapless metal oxide varistor individually fused. Gas tubes or silicon avalanche shall not be used. When module performance is degraded, as if one or more fuses or varistors have failed, a light emitting diode (LED) indicator shall indicate a failed module.

2.24.4.1 Fault Conditions

Occurrence of any of the above fault conditions shall result in the immediate removal of the drive's run command, the clamping of the internal current regulator, the opening of armature loop and an emergency dynamic brake stop. Drive system shall also notify the car controller of shutdown via a drive status signal. Car controller shall respond to continuous-drive reset pulses which shall reset the drive as soon as fault condition clears, if it is not a hard failure such as blow fuse, and shall return elevator to service. The dc direct-drive system shall be designed to include input impedance to filter out electro-mechanical noise on SCR drive system.

2.25 SENSOR AND CONTROL WIRING SURGE PROTECTION

****

NOTE: Determine if additional control inputs or outputs require surge protection and show requirements on drawings, either in a schedule or on input/output summary tables.

****

Digital and analog inputs shall be protected against surges induced on control and sensor wiring. Digital and analog outputs shall be protected, as shown against surges induced on control and sensor wiring installed outdoors. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

a. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An eight microsecond rise time by 20 microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

2.26 COMMUNICATIONS LINKS SURGE PROTECTION

****

NOTE: Determine if additional communications inputs or outputs require surge protection and show requirements on drawings, either in a schedule or on input/output summary tables.

****

Communications equipment shall be protected against surges induced on any communications link. Cables and conductors, except fiber optics, which serve as communications links from motor control room (MCR) to field equipment, and between field equipments shall have surge protection circuits installed at each end. Protection shall be furnished at equipment and additional triple electrode gas surge protectors rated for the application on each wireline circuit shall be installed within 3 feet of the building cable entrance. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

a. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An eight microsecond rise time by 20 microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

2.27 COMMUNICATIONS LINKS OVER VOLTAGE PROTECTION

****

NOTE: Determine if additional inputs or outputs require surge protection and show requirements on drawings, either in a schedule or on input/output tables.

****

Communications equipment such as MODEMs, line drivers, and repeaters shall be protected against overvoltage on communications link conductors. Cables and conductors, which serve as communications links, except fiber optics, shall have overvoltage protection for voltages up to 480 Vac rms, 60 Hz installed. Instrument fuses or fusible resistors are required for this application.

2.28 COMPENSATION

****

NOTE: Provide chain compensation for freight elevators having a travel in excess of 30 m (100 feet), and rope compensation for passenger elevators having a travel in excess of 40 m (130 feet) and speeds in excess of 2.5 m/s (500 feet per minute). Rope tie-down compensation is required for elevators having speeds in excess of 3.5 m/s (700 feet per minute).

****

Plastic-covered chains shall be provided to compensate for weight of hoisting ropes and unbalanced portion of traveling cables. [Compensation chains shall be securely fastened to underside of car and counterweight frame with double loops and "S" hooks to open, if chain should become taut for any reason]. [A 4 inch minimum diameter, neoprene-covered roller with slotted brackets attached to counterweight rails shall be provided and located in the bight of the chain. A contact shall be provided on the assembly so that if the chain leaves its normal position, it will pull the roller out of its brackets, open the contact, and stop the elevator.]

2.28.1 Rope Compensation (Cables)

Ropes of same construction as hoisting ropes shall be provided. For cars with rated speed greater than 700 fpm, tie down compensation shall be provided.

2.28.2 Solid-State Control with Integral Compensation

Solid-state control compensation up to and including 150 feet of travel for 1:1 roping, or 130 feet of travel for 2:1 roping shall be provided.

2.29 COUNTERWEIGHT

****

NOTE: When occupied space occurs beneath the elevator hoistway, counterweight speed governors and

counterweight safeties must also be provided. Delete requirement for counterweight guard if either chain or rope compensation is specified.
****

Counterweight for each car shall equal the weight of car plus approximately 40 percent of specified load. Concrete weights are not acceptable. [Counterweight safeties shall be provided.] [Counterweight screen of metal construction, at least 6 feet high, shall be provided as a protective guard at bottom of hoistway, except where the type of hoisting rope compensation prevents this type of installation.]

2.30 LEVELING DEVICES

****
NOTE: Select either 6 mm (1/4 inch) for variable voltage control or 25 mm (1 inch) for ac rheostatic control.
****

Elevators shall be equipped with a 2-way leveling device to automatically bring the car to the floor landings. Car shall automatically relevel at each landing to correct overtravel and undertravel, and maintain the level regardless of load on the car, rope slippage or stretch of cables. Electric stopping system shall be arranged so the car will stop level with the floor before brake is set. Stopping accuracy shall not exceed plus or minus [1/4] [1] inch.

2.31 BUFFERS

****
NOTE: Oil buffers are required for speeds in excess of 1 m/s (200 feet per minute).
****

Buffers shall be of design suitable for depth of pit. Buffer anchorage at pit floors shall be provided for each car and counterweight and arranged to avoid puncturing of the pit waterproofing. Type of buffer used shall be tested and approved for compliance with elevator service requirements. Pipe struts and steadiers shall be provided as required by pit conditions. A metal plate with information concerning stroke and load-rating shall be permanently fastened to each buffer. Pit-mounted buffers shall have an adequate stroke designed to bring the fully-loaded car and counterweight to rest from governor tripping speed at an average rate of retardation not exceeding gravity. Moving portion of buffer shall be designed to be accelerated by the car without a noticeable peak retardation. [Oil buffers shall be of the spring-return type, except that counterweight buffers attached to counterweight may be the gravity-return type. Provisions shall be made for checking oil level. Switches shall be provided for spring-return oil buffers.] [Spring buffers shall be in accordance with ASME A17.1.]

2.32 LUBRICATION POINTS

Every part subject to movement friction shall be complete with provisions for oil and grease lubrication.

2.33 SEISMIC REQUIREMENTS

****

NOTE: Provide seismic details, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the non-appropriate bracketed phrase.

****

Seismic protection shall be provided in conformance with TI 809-04 for general guidance and computation of forces (1.O G horizontal and 1.0 G vertical minimum), ASME A17.1, Rule XXIV, and ICBO Bldg Code [as shown on the drawings]. [The contractor shall hire a registered engineer to submit the stamped calculations and drawings.]

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: ASME A17.1 must be consulted for information, such as vertical support spacing and loading conditions; the drawings should indicate supporting devices.

****

Elevators and equipment shall be installed in accordance with ASME A17.1 and manufacturer's recommendation. Guide rails shall be set plumb and parallel and attached to guide rail brackets secured to building framing as indicated and at intervals not exceeding [_____] inches. Steel plate shims shall not be used for aligning equipment. Guide rail sections shall be joined rail sections, joined together in accordance with ASME A17.1. Guide rails shall be thoroughly cleaned and made smooth before elevator is put into operation. During installation stainless steel surfaces shall be protected.

3.2 FIELD WELDING

When structural or load-bearing members are to be field-welded, welding and qualification of welders shall be as specified in Section 05090 WELDING, STRUCTURAL.

3.3 ELEVATOR WIRING

Wiring shall be provided for electrically-operated items of elevator equipment to comply with requirements of NFPA 70 and Section 16415 ELECTRICAL WORK, INTERIOR. For control and signal circuits wire shall be minimum No. 16 AWG. For power and lighting circuits wire shall be minimum No. [12] [_____] AWG. A work light fixture equipped with 150 watt incandescent lamps and ground duplex receptacles shall be provided at both the top and bottom of the car. Work light fixtures and traveling cable junction boxes shall be located to provide illumination at junction boxes. Wiring shall terminate in junction boxes. Wires shall be identified and match symbols shown on wiring diagrams. Control and signal wires shall be brought to accessible numbered terminal blocks on controller. Intra-panel wiring shall be flame-resisting type.

3.3.1 Traveling Cables

Cables shall terminate at numbered terminal blocks in car and machine room. Traveling cable shall be provided with a separate shielded circuit for communication system and hang to obtain proper size of loop. Traveling cable shall be provided with 10 percent spare conductors for each car.

3.4 PAINTING

Except for factory finished items and corrosion-resistant items, machined surfaces shall be painted as specified in Section 09900, PAINTING, GENERAL.

3.5 TESTING

****
NOTE: The designer will determine if a certified government elevator inspector is available to witness final testing and certify the elevator. If a government elevator inspector is not available, the designer will specify that the Contractor provides an inspector to certify the elevators. the designer will also determine if inspection by local or state authorities is required and, if required, specify the requirements accordingly.
****

Testing shall be in accordance with requirements of ASME A17.1 and ASME A17.2.1 and as specified below. Contractor shall conduct a complete test of the system. After the system has passed all tests, the Contractor shall notify the Contracting Officer in writing, [_____] days prior to the time of performing the acceptance test, that the system is complete and is ready for final acceptance testing. The Contractor after receiving written approval from the Contracting Officer will conduct a complete acceptance test of the system. [Acceptance testing will be witnessed by a certified government elevator inspector.] [The Contractor shall provide the services of an elevator inspector, employed by an independent testing company to inspect the elevators, witness the acceptance testing and certify the elevators. The inspector shall meet all qualification requirements of ASME QEI-1 and shall be certified in accordance with ASME QEI-1. The Contractor shall provide an elevator certificate signed by the inspector for each elevator. The certificate shall be provided to the Contracting Officer within 30 days after completion of all testing.]

3.5.1 Testing Period

Each elevator shall be tested with the specified rated-load in car continuously for a period of 35 percent of the duty time. During the test run the car shall be stopped at all floors in both directions of travel for a standing period of 10 seconds per floor. A manual test of the final limits (UP and DOWN overtravel) shall also be performed.

3.5.2 Speed Load Testing

****
NOTE: Specify 10 percent for ac rheostatic control and 5 percent for variable voltage control.
****

The actual speed of elevator car in both directions of travel shall be determined with the rated-load and with no-load in the elevator car.

Actual measured speed of car with the rated-load in the UP direction shall be within [5] [_____] percent of rated speed. The maximum difference in actual measured speeds obtained under the various conditions outlined shall not exceed 10 percent of the total difference between the UP and DOWN speeds.

3.5.3   Car Leveling Testing

Elevator cars leveling devices shall be tested for accuracy of landing at all floors with no-load in car, with symmetrical load in car and with the rated-load in car in both directions of travel.

3.5.4   Brake Testing

Brake test shall be conducted with the rated-load in the car. Brakes shall stop and hold the car with the rated-load. In elevators using a Ward-Leonard type generator drive system it is critical to test the suicide circuit to assure that loop currents cannot cause the hoist motor to pull through the brakes.

3.5.5   Temperature Rise Testing

Temperature rise of hoistway motor, motor drive, exciter and booster shall be conducted during the full-load test run for minimum one hour. Under these conditions the temperature rise of equipment shall not exceed the requirements established in NEMA MG 1 Chapter 12. Temperature rise testing shall be started when all parts of equipment are within the temperature required by NEMA at the time of starting the tests.

3.5.6   Insulation-Resistance Testing

Insulation-resistance testing shall be performed to ensure that the complete elevator wiring systems will be free from short circuits and grounds. Electrical conductors shall have an insulation-resistance of not less than one megohm between each conductor and ground, and not less than one megohm between each conductor and all other conductors. Prior to testing, provisions shall be made to prevent damage to electronic devices.

3.6   FRAMED INSTRUCTIONS

Two sets of instructions shall be typed and framed under glass or in laminated plastic, and posted side-by-side in the elevator room where directed, before acceptance of elevator systems. First set of instructions shall include wiring and control diagrams showing the complete layout of elevator system. Second set of instruction shall include the condensed operating instructions explaining preventive maintenance procedures, the methods for checking the elevator system for normal safe operation, and the procedures for safely starting and stopping the elevator system.

3.7   OPERATOR TRAINING

Contractor shall conduct a formal training course for operating Government personnel which shall include care, lubrication, adjustment and maintenance of the elevator equipment. Training period of the elevator equipment. Training period shall consist of a total of [_____] hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. Field instructions shall cover all of the items contained in the operating and maintenance instructions, including demonstrations of routine maintenance operations. The Contracting Officer shall be notified at least 14 days prior to date of starting the training course.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-14601 (April 1994)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**
CECW-EE **Superseding**
CWGS-14601 (April 1994)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes Metric Conversion Special Change
Includes Special Change to convert CWGS-14601 (w/N1 June 94) to one CEGS system and to renumber the specifications in accordance with the 1995 CSI MASTERFORMAT. (September 1998) This is not a Technical Update.
Includes Special Change to replace Fed Spec (December 1998)
Includes Special Change to reconcile Reference Organization Names and CEGS-01090 (December 1998)
Includes Text Adjustment (December 1998)
Includes Text Adjustment (March 1999)
****

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04/94

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SECTION 14601

CRANES, BRIDGE & GANTRY, TOP RUNNING, 30-TON MAXIMUM CAPACITY
04/94

****
NOTE: This guide specification covers the requirements for top-running bridge and gantry multiple-girder electric overhead traveling cranes with capacities of 27.2 tons (metric) (30 tons (2000 lb)) or less, suitable for indoor or outdoor use in hazardous or non-hazardous environments for use at civil works projects. This guide specification is to be used in the preparation of project specification in accordance with ER 1110-2-1200 and ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: See Additional Note A.
****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications shall be the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
AFBMA 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 390.03a	(1980; Errata 1983) Gear Handbook Gear Classification, Materials and Measuring Methods for Bevel, Hypoid, Fine Pitch Wormgearing and Racks Only as Unassembled Gears
AGMA 2000-A	(1988; Errata Jan 89, Errata Jul 90) Gear Classification and Inspection Handbook, Tolerances & Measuring Methods for Unassembled Spur and Helical Gears (including Metric Equivalents)
AGMA 2001-B	(1988; Errata Jun 90) Fundamental Rating Factors & Calculation Methods for Involute Spur and Helical Gear Teeth
AGMA 6010-E	(1988; Errata Nov 91) Standard for Spur, Helical, Herringbone and Bevel Enclosed Drives
AGMA 6019-E	(1989) Gearmotors Using Spur, Helical, Herringbone, Straight Bevel, or Spiral Bevel Gears
AGMA 6021-G	(1989) Shaft Mounted and Screw Conveyer Drives Using Spur, Helical and Herringbone Gears

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC-S329	(1986) Allowable Stress Design Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C80.1	(1990) Rigid Steel Conduit - Zinc Coated

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 159	(1983; R 1993) Automotive Gray Iron Castings
ASTM A 325	(1993) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 325M	(1993) High-Strength Bolts for Structural Steel Joints (Metric)
ASTM A 490	(1993) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
ASTM A 490M	(1993) High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM A 668/A 668M	(1993) Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM B 209	(1992a) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	(1992a) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 438	(1983a; R 1989) Sintered Bronze Bearings (Oil-Impregnated)
ASTM B 438M	(1984; R 1989) Sintered Bronze Bearings (Oil-Impregnated)
ASTM B 439	(1983; R 1989) Iron-Base Sintered Bearings (Oil-Impregnated)
ASTM B 612	(1991) Iron Bronze Sintered Bearings (Oil-Impregnated)

ASME INTERNATIONAL (ASME)

ASME B30.2	(1990; B30.2a; B30.2b) Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1994) Structural Welding Code - Steel
AWS D14.1	(1985) Welding of Industrial and Mill Cranes and Other Material Handling Equipment

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-55810	(Rev C; Notice 1) Conduit, Metal, Flexible

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA 397	(1972; R 1979) Thyristors
EIA 397-1	(1980) Thyristors, Correction Notice

FEDERAL SPECIFICATIONS (FS)

FS RR-W-410	(Rev D; Am 1) Wire Rope and Strand

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 597	(1983; R 1992) General Purpose Thyristor for DC Drives

MATERIAL HANDLING INDUSTRY (MHI)

MHI CMAA 70	(1988) Electric Overhead Traveling Cranes

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(1986; Rev 1) Molded Case Circuit Breakers
NEMA ICS 1	(1988; Rev 1 and 2) Industrial Controls and System
NEMA ICS 2	(1988) Industrial Control Devices, Controllers and Assemblies
NEMA ICS 3	(1988; Rev 1) Industrial Systems
NEMA ICS 4	(1983; R 1988; Rev 1) Terminal Blocks for Industrial Use
NEMA ICS 6	(1988; Rev 1) Enclosures for Industrial Control and Systems
NEMA MG 1	(1993) Motors and Generators
NEMA ST 1	(1988) Specialty Transformers (Except General-Purpose Type)
NEMA WC 3	(1980; R 1986; Rev 1, 2, 3, 4, 5, and 6) Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 7	(1988; Rev 1) Crosslinked-thermosetting-polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 8	(1988; Rev 1) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1993) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 489	(1991; Rev thru Jan 1994) Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
UL 943	(1993) Ground-Fault Circuit-Interrupters
UL 1004	(1989; Rev thru Mar 1993) Electric Motors
UL 1449	(1985; Errata Apr 1986) Transient Voltage Surge Suppressors

1.2 UNIT PRICES

****

NOTE: Delete paragraph UNIT PRICES and incorporate appropriately edited paragraphs from this note into Section 01270 MEASUREMENT AND PAYMENT.

a. "___________________________"

(1) Payment will be made for costs associated with ______________ ____.

(2) _______________________ will be measured for payment based upon ____.

(3) Unit of measure: ___________.

b. "___________________________"

(1) Payment will be made for costs associated with ______________ ____.

(2) _______________________ will be measured for payment based upon ____.

(3) Unit of measure: ___________.

****

1.3 SYSTEM DESCRIPTION

1.3.1 General Requirements

1.3.1.1 Standard Products

Materials and equipment shall be standard products of manufacturers regularly engaged in the fabrication of cranes and shall essentially duplicate items which have been in satisfactory use for at least 2 years prior to bid opening. Any company licensed by a crane manufacturer to manufacture cranes bearing their name shall have the design and components approved by the licensor prior to submission to the Government for approval.

1.3.1.2 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or catalog number, and serial number on a metal plate secured to the equipment.

1.3.1.3 Verification of Dimensions

The Contractor shall verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing any work.

1.3.1.4 Welding

Welding shall be in accordance with qualified procedures using AWS D14.1 as modified. Written welding procedures shall specify the Contractor's standard dimensional tolerances for deviation from camber and sweep and such tolerances shall not exceed those specified in AWS D14.1. All welding shall be performed indoors. Welders and welding operators shall be qualified in accordance with AWS D1.1 or AWS D14.1. Allowable stress values shall be in accordance with MHI CMAA 70.

1.3.2 Design Criteria

The cranes shall be designed to operate in the spaces and match the runway dimensions and rails indicated. The hook coverage and hook vertical travel shall not be less than that indicated.

1.3.2.1 Classification

****
NOTE: See Additional Note C.
****

The crane shall be designed and constructed to MHI CMAA 70 Class [_____], [_____] Service requirements for operation in [indoor] [outdoor] [hazardous] [nonhazardous] environment.

1.3.2.2 Rated Capacity and Speeds

****
NOTE: See Additional Note D.
****

The rated capacity of the crane shall be [_____]tons (2000 lb). [The auxiliary hoist capacity shall be [_____] tons(2000 lb).] The lower load block and hook shall not be considered part of the rated capacity. Rated speeds (in feet per minute) for the hoist, [bridge] [gantry] and trolley shall be as follows:

Rated Speeds (fpm)

	Maximum
Main Hoist	[_____]
[Auxiliary Hoist]	[_____]
Trolley	[_____]

[Bridge] [Gantry]   [_____]

1.3.2.3   Capacity Plates

Two capacity plates shall be provided, one for each side of the [bridge] [gantry]. Each plate shall be lettered to indicate the total rated hoisting capacity of the crane. All lettering shall be of sufficient size to be easily read from the floor. Each lower load block shall be marked with the hoist rated capacity.

1.3.2.4   Stability

****

NOTE: Applicable only if the crane is a gantry, otherwise delete paragraph.

****

The gantry crane shall have a minimum factor of safety of 1.25 against overturning under each condition of loading stated in paragraph 3.3.2.4 of MHI CMAA 70. Counterweights shall be provided if necessary to obtain the required stability.

1.4   SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.
Indicate submittal classification using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

[Bridge] [Gantry] Crane System; [_____].

A complete list of equipment and materials, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions.

Spare Parts; [_____].

Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than [_____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-04 Drawings

[Bridge] [Gantry] Crane System; [_____].

Detailed drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-06 Instructions

[Bridge] [Gantry] Crane System; [_____].

Diagrams, instructions, and other sheets proposed for posting.

SD-09 Reports

Acceptance Testing; [_____].

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. The report shall include the information as required by paragraph ACCEPTANCE TESTING.

SD-18 Records

Hooks; [_____].

Record of hook material and any heat treatment performed shall be stamped on the hook shank or documented in certification papers furnished with the hooks.

SD-19 Operation and Maintenance Manuals

[Bridge] [Gantry] Crane System; GA.

[Six] [_____] copies of operation manuals and [six] [_____] copies of maintenance manuals shall be supplied for the equipment furnished. One complete set shall be furnished prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Operation manuals shall include a copy of the acceptance test report for information and future reference. Operation manuals shall include an overall description of the system describing any unique features that may need special attention. Maintenance manuals shall provide step-by-step description of routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping layout diagrams, equipment layout diagrams, and detailed wiring and control diagrams of the system as installed. Maintenance manuals shall include a spare parts list of manufacturer's recommended spare parts that should be maintained on-site and any long lead time items should be clearly identified. Operation and maintenance manuals shall be approved prior to the field training course.

1.5 DELIVERY AND STORAGE

Equipment delivered shall be placed in indoor storage, protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 STRUCTURAL MATERIALS

2.1.1 Bolts, Nuts, and Washers

Bolts, nuts, and washers shall conform to ASTM A 325M ASTM A 325 bolts. High strength bolted connections shall conform to the requirements of AISC-S329, except that ASTM A 490 bolts shall not be used. No galvanized bolts shall be used.

2.1.2 [Bridge] [Gantry] Girders

****

NOTE: Specify welded structural steel box sections for multiple girder cranes Class C, D, or E with a capacity greater than 18.1 tons (metric) (20 tons (2000 lb)) or a span greater than 12 meters (40 feet).

****

[Bridge] [Gantry] girders shall be [welded structural steel box sections] [wide flange beams, standard I-Beams, reinforced beams or sections fabricated from rolled plates and shapes].

2.1.3 [Bridge] [Gantry] Rails

The [bridge] [gantry] rail shall be fastened to the top cover plate with welded clips. [Bridge] [Gantry] rail joints shall be bolted using standard joint bars. Rail joints shall be staggered.

2.1.4 End Ties and [Bridge] [Gantry] Girder End Connections

****

NOTE: Specify welded structural steel box sections for multiple-girder cranes Class C, D, or E with a capacity greater than 18.1 tons (metric) (20 tons (2000 lb)) or a span greater than 12 meters (40 feet).

****

[Welded steel box sections shall be used for end ties, full-depth diaphragms shall be provided at girder connections and jacking points.] Horizontal gusset plates shall be provided at the elevation of the top and bottom end tie flanges for connection to girder ends. End connections shall be made using high-strength bolts. Body bound bolts fitted in drilled and reamed holes shall be used to maintain the crane square.

2.1.5 [Bridge] [Gantry] End Trucks

End trucks shall be fabricated from structural steel providing a rigid structure and shall be the rotating or fixed axle type. Jacking pads shall be provided for removal of wheel assemblies.

2.1.6 Trolley Frame

Trolley frame shall consist of two structural steel side frames or trucks welded together with one or more structural steel load girts to form a one-piece unit. Pads shall be provided for the use of jacks or wedges when changing truck wheels.

2.1.7 Stops and Bumpers

[Structural stops] [Bumpers] shall be provided on the [bridge] [gantry] to engage [bumpers] [structural stops] located at the ends of the runway rails. [Structural stops] [Bumpers] shall be provided on the trolley to engage [bumpers] [structural stops] located at the ends of the [bridge] [gantry] rails. Stops shall be located to permit maximum [bridge] [gantry] and trolley travel. Structural stops and bumpers shall be designed and installed in accordance with MHI CMAA 70.

2.1.8 Footwalks

The location and construction of footwalks shall be in accordance with ASME B30.2. A footwalk shall be provided on the drive side. [To give access to the opposite side of the trolley, [bridge] [gantry] conductors, or other equipment, a footwalk twice the length of the trolley, shall be mounted on the opposite side of the crane. A cross-over footwalk shall be provided over an end tie between the two girder footwalks.] The drive side footwalk shall mate with the crane access platform. Footwalks and platforms shall be safety tread (raised pattern). The length of the drive side footwalk shall be [adequate to provide access to the trolley and provide sufficient room for mounting control cabinets] [along the entire length of the [bridge] [gantry]]. Safety handrails shall be provided for footwalks.

2.1.9 Runway Rails

****

NOTES: Use the first optional sentence if the runway rails are furnished and installed by the Government. Indicate what rail is used for runway rails.

Use the second optional sentence if the runway rails are to be furnished and installed by the Contractor.

****

[The runway rails for the [bridge] [gantry] travel are existing and are [_____].] [The runway rails for the [bridge] [gantry] travel shall be of the size recommended by the crane manufacturer and shall be in accordance with MHI CMAA 70.]

2.1.10 Additional Provisions for Outside Service

****

NOTE: Applicable for outdoor cranes only.

****

Welded structural members on outdoor cranes shall be seal welded. Cranes shall be provided with parking brakes sufficient to hold the crane against a wind pressure of 5 psf. Cranes shall be provided with manually operated rail clamps at each rail, designed to securely anchor the crane against a wind pressure of 30 psf.

2.2 MECHANICAL EQUIPMENT

2.2.1 Drives

2.2.1.1 [Bridge] [Gantry] Drives

****
NOTE: If the span is less than 18 meters (60 feet), A-1 drive may be included as an option. The A-1 drive may only be used for bridge cranes.
****

[Bridge] [Gantry] drives shall be [either the A-1 or] A-4 drive arrangement as specified in MHI CMAA 70.

2.2.1.2 Trolley Drives

The trolley shall have a drive arrangement that has two wheels driven.

2.2.2 Load Blocks

2.2.2.1 Main [and Auxiliary] Hoist Load Blocks

Load blocks shall be of steel construction. The load block frame shall be completely enclosed except for rope openings. Load blocks shall be provided with a forged steel crosshead, separate from the sheave pin, with swivel mounting for the hook. Sheave bearing lubrication fittings shall be recessed within the sheave pin or adequately guarded to prevent damage.

2.2.2.2 Hook Assembly

****
NOTE: If specific hook dimensions are provided in the drawings, include the appropriate sentence; otherwise manufacturer's standard hook will be provided. If hooks are required to be disassembled and inspected, include appropriate sentence.
****

Hooks shall be single barbed and shall be made of forged steel complying with ASTM A 668/A 668M. [Hook dimensions shall be as shown .] All hooks shall be fitted with safety latches designed to preclude inadvertent displacement of slings from the hook saddle. No painting or welding shall be performed on the hook. [Hooks are required to be periodically disassembled, inspected, and nondestructively tested; therefore the hook nut shall be secured by a set screw or other similar, easily removable securing device, but shall not be welded.] Hooks shall be commercially rated and shall have a minimum proof load of twice the safe working load and have a minimum straightening load of four times the safe working load.

2.2.3 Hoisting Ropes

Hoisting ropes shall be regular lay, preformed, uncoated, improved or extra improved plow steel, 6 by 37 construction, with independent wire rope core conforming to FS RR-W-410, Type I, Class 3. The hoisting ropes shall be selected such that the rated capacity load plus the load block weight divided by the number of parts of rope shall not exceed 20 percent of the certified breaking strength of the rope. Hoisting ropes shall be secured to the hoist drum so that no less than three wraps of rope remain at each anchorage of the hoist drum at the extreme low position (limit switch stop).

2.2.4   Sheaves

Sheaves shall be of cast steel, forged, rolled, or welded structural steel. Sheave grooves shall be accurately machined, smoothly finished, and free of surface defects.

2.2.5   Hoist Drums

Hoist drums shall be of welded rolled structural steel, cast steel, or seamless steel pipe. Drums shall be machined and provided with grooves, including two dead grooves at each of the two anchor points.

2.2.6   Gearing

Gearing shall be of the enclosed (gear reducers) or open type. The gears and pinions shall be spur, helical, or herringbone type only, and shall be forged, cast or rolled steel, except that drum gears may be of welded construction.

2.2.6.1   Gear Reducers

Gear reducers shall be the standard items of manufacturers regularly engaged in the design and manufacture of gear reducers, or they shall be integral components of standard hoists or hoist/trolley units of manufacturers regularly engaged in the design and manufacture of hoists or hoist/trolley units. Gear reducers shall be designed, manufactured, and rated in accordance with AGMA 6010-E, AGMA 6019-E, or AGMA 6021-G (for trolley drives only), as applicable.

2.2.6.2   Open Gearing

All gears and pinions shall have adequate strength and durability for the crane service class and manufactured to AGMA 2001-B quality class 6 or better precision per [AGMA 390.03a] [AGMA 2000-A]. Open gears shall be enclosed with safety guards provided with openings with covers for inspection and access for grease lubrication.

2.2.7   Brakes

Brakes shall be shoe or disc with thermal capacity suitable for Class [_____] Service. Shoe and disc brakes shall be spring set and electrically released by a continuously rated direct acting magnet. All brakes shall be self-aligning and provide for easy adjustment for torque setting and lining wear. Brake wheels shall be cast iron conforming to ASTM A 159 or shall be the manufacturer's standard high-strength ductile cast iron, provided that the material exhibits wear characteristics in the form of powdered wear particles and is resistant to heat checking. Disc brakes shall be totally enclosed and have multiple discs with stationary releasing magnets. Brake torque shall be easily adjustable over a 2:1 torque range.

2.2.7.1   Hoist Holding Brakes

****

NOTE: If noncritical loads are handled, one hoist holding brake with a torque rating of 150 percent of

motor full load torque should be specified. If critical or hazardous loads are handled, two holding brakes with a torque rating of 125 percent of motor full load torque should be specified. Specify two holding brakes for DC control systems.
****

Each hoist shall be equipped with at least [one] [two] holding brake(s). The holding brake shall be a friction brake of the shoe design and shall be applied to the motor shaft or to the gear reducer shaft.

2.2.7.2 Hoist Control Brake

****
NOTE: Specify a mechanical load brake or an eddy-current brake. Mechanical load brakes are used for Classes A, B, C, and D cranes where service is not severe. Mechanical load brakes provide poor control characteristics under light loads relative to rated load. Specify electrical control braking where mechanical braking is not used.
****

[Each hoist shall be equipped with an integral mechanical load brake-"Weston" or multiple-disc. The multiple-disc brake shall be provided with external adjustment for wear.] [Each hoist shall be provided with an electric control brake to prevent overspeeding.]

2.2.7.3 Trolley Brake

The trolley braking system shall have shoe or disc brakes that are spring applied and electrically released.

2.2.7.4 [Bridge] [Gantry] Brakes

The [bridge] [gantry] braking system shall provide a single-shoe or disc brake for each [bridge] [gantry] drive motor. The [bridge] [gantry] brakes shall be spring applied and electrically released.

2.2.8 Wheels

****
NOTE: Include the sentence in brackets for MHI CMAA 70 classes D and E cranes; otherwise delete. Straight treads for [bridge] [gantry] wheels should only be specified on A-1 type drives.
****

The wheels shall be made of rolled or forged steel. [The wheel treads and flanges shall be rim toughened to between 320 and 370 Brinell hardness number.] [Bridge] [Gantry] [and trolley] wheels shall be double flanged. Trolley wheels shall have straight treads. [Bridge] [Gantry] wheels shall have [tapered] [straight] treads.

2.2.9 Bearings

All bearings, except those subject only to small rocker motion, shall be of the antifriction type. Load ratings and fatigue life shall be in accordance with AFBMA 9and AFBMA 11 Equalizer sheaves shall be equipped with sintered oil impregnated type bushings in accordance with ASTM B 438, ASTM B 439, or ASTM B 612.

2.2.10   Antidrip Provisions

The cranes shall be designed to preclude leakage of lubricants onto the lifted loads or the floor. Equipment and components which cannot be made leak-proof shall be fitted with suitable drip pans. The drip pans shall be made of steel and shall be designed to permit removal of the collected lubricant.

2.2.11   Lubrication System

A splash oil lubrication system shall be provided for the hoist, trolley and [bridge] [gantry] gear cases, except that an oil pump shall be used on vertical mounted gear cases exceeding two reductions. Oil pumps shall be reversible and capable of maintaining the same oil flow direction and volume while being driven in either direction. Electric motor-driven pumps may be used when the input shaft speed is too low at any operating condition to ensure adequate oil flow. In such applications, the pump shall be energized whenever the drive mechanism brakes are released.

2.2.11.1   Electrically Driven Oil Pump Alarm

If an electric-driven lubricating pump is used, an audible alarm and red indicating light shall be provided and shall be energized in the event of pump malfunction.

2.3   ELECTRICAL COMPONENTS

2.3.1   Power Supply

****

NOTES: Select enclosed safety rail system or cable reel for:

a. Indoor nonhazardous service
b. Outdoor noncorrosive environment

Select festoon or cable reel system for:

a. Indoor - hazardous service
b. Outdoor - corrosive (marine) environment

****

2.3.1.1   General

****

NOTES: Use the first optional paragraph for installations using cable and a reel for the normal supply.

Use the second optional paragraph for installations using a Government-furnished main contact conductor system.

Use the third optional paragraph for installations using a Contractor-furnished main contact conductor system.
****

[Electric power for the normal operation of the crane will be supplied from the nominal [_____] volt, 3-phase, ungrounded, 60-Hz ac power distribution system.]

[Electric power for the normal operation of the crane will be supplied from the nominal [_____] volt, three-phase, ungrounded, 60-Hz, AC power distribution system. The power supply circuit and the main contact conductor system will be furnished and installed by the Government as shown.]

[Electric power for the normal operation of the crane will be supplied by a Government furnished and installed feeder from the nominal [_____] volt, three-phase, 60-Hz, AC, ungrounded power distribution system. The main contact conductor system will be located as shown the drawings. The power shall be brought into the crane by a suitable collector. The main contact conductor and collector system shall be furnished by the Contractor and the contact conductor system and all the required mounting accessories shall be delivered to the site for installation by the Government under another contact.]

2.3.1.2   Incoming Power Supply

****
NOTE: Use this paragraph for installations using cable and a reel for normal supply. If this paragraph is used, delete paragraph MAIN CONTACT CONDUCTORS AND COLLECTORS below.
****

a. General - Incoming power from the above power receptacles shall be brought into the crane by means of a Type G, three-conductor, 600-volt rubber or rubber-like insulated and extra-heavy-duty neoprene-jacketed portable power cable. The cable shall have a usable length of not less than [_____] feet, and shall be wound upon the cable reel to be furnished and mounted on the crane. The power plug shall be installed on the free end of the cable and an anchorage shall be provided to relieve the power plug and receptacle from the strain of reeling and unreeling the cable. The grounding conductors shall make electrical connection to the crane structure through the fourth collector ring and brush of the cable reel and shall be connected to the ground terminal of the power plug.

b. Cable Reel - The cable reel shall be rated for constant duty, [_____] amperes continuous, 600-volt AC, shall be provided with four collector rings and brushes, shall be of weather-proof construction, shall maintain approximately uniform tension in the cable, and shall automatically "pay out" and "take up" the cable as required by the crane travel. The cable reel shall be provided with a positive driven or actuated limit switch that will prevent excess "takeup". The reel shall be mounted on the crane in a location, as approved , that will allow ready maintenance and inspection as well as satisfactory operation.

2.3.1.3   Main Contact Conductors and Collectors

****

NOTES: Delete paragraph INCOMING POWER SUPPLY above if this paragraph is used.

Use the first optional paragraph for installations using a Government-furnished main contact conductor system.

Use the second optional paragraph (including subparagraphs a. and b.) for installations using a Contractor-furnished main contact conductor system.

****

[A contact conductor system and collector of adequate current-carrying capacity will be furnished and installed by the Government as shown. The collector assembly will be shipped to the Contractor's plant for coordination of the mounting and wiring on the crane by the Contractor. The Contractor shall furnish all additional brackets and bolts that may be required.]

[The contact conductor system shall be furnished complete with collector and all necessary accessories for mounting the contact assembly as shown.

a. Conductor - The contact conductor system shall be enclosed and shall be rated for 600 volts AC. It shall have a continuous current carrying capacity as required by the connected load of the crane and as required to hold the voltage drop to not more than 1 percent from the power input connection at the main contact conductors to the input terminals of the crane main circuit breaker when the crane is operating with the greatest load condition and is at the maximum distance from the point of connection of the power feeder. Mounting supports shall provide means to accommodate contraction and expansion due to temperature changes and to permit installation with proper alignment. The mounting supports shall be spaced at intervals that will limit the maximum deflection of the contact conductors to not more than 1/16 inch, but in no case shall the spacing intervals of the supports be more than 10 feet. All mounting bolts and screws shall be of a suitable corrosion resisting material. Standard products of the manufacturer furnishing the conductors shall be provided to connect the power supply to the conductors. Contraction and expansion sections shall be provided at each monolith joint. Except as otherwise specified, the contact conductor system shall conform to the following:

(1) Conductor insulation shall be nonburning and suitable for outdoor service at an ambient temperature of 100 degrees F. It shall be designed and installed to accommodate independent and/or unequal movements of the conductors and enclosures.

(2) Stainless steel hanger clamps with insulators shall be used to support the insulated conductor.

(3) An ice shield shall be provided and arranged to prevent icing of the conductors or collectors. The shield, shield straps, and strap nuts shall be made of aluminum conforming to ASTM B 209, Alloy 3003, Temper H14. The shields shall be not less than 0.050

inch in thickness and the shield strap nuts shall be not less than 0.125 inch in thickness. Bolts and screws shall be made of stainless steel. The ice shield shall be provided with expansion and contraction joints.

b. Collector - Collector shall have two individually spring loaded conductor contact shoes for each phase or for each main conductor, shall have no exposed current carrying surfaces, and shall be articulated, if necessary, to maintain full contact against the contact conductor. Contact shoes shall be of graphite bronze or other suitable material as approved and shall be suitable for use with contact conductors furnished. The collector mounting shall provide means for adjustment as required to make proper contact and to travel properly on the contact conductors. Supporting wheels, if required, shall be provided with self-lubricating bearings.]

2.3.1.4 Incoming Power Circuit Breaker

The crane's normal power supply shall be controlled by means of a [_____] volt, three-pole, manually operated air circuit breaker having a suitable ampere rating. Short circuit protection only shall be provided. The breaker shall be mounted on the protective panel.

2.3.2 TROLLEY CONDUCTORS AND COLLECTORS

2.3.2.1 Contact Conductors

****

NOTE: Use this paragraph if the trolley is to use a conductor-collector system. If this paragraph is used, delete paragraph FESTOON CONDUCTORS below.

****

Trolley contact conductors shall be continuously insulated solid copper conductor. They shall be mounted on the inside surfaces of the bridge girders and supported at intervals such that the maximum deflection at any point on the contact conductor surfaces produced by contact with the collectors shall not exceed 1/16 inch, but in no case shall the interval be greater than 6 feet. Rigid angle contact conductors and shoe spacing providing less than 4 inches between live parts and between live parts and ground will require the approval of the Contracting Officer. The insulators for the rigid copper angles shall be furnished with studs and inserts and shall have a service rating of not less than 1,000 volts. The bar type conductor shall be provided with insulated hanger clamps having a mushroom insulator.

2.3.2.2 Collectors

****

NOTE: Use this paragraph if the trolley is to use a conductor-collector system. If this paragraph is used, delete paragraph FESTOON CONDUCTORS below.

****

Collectors for the contact conductors shall be such as to minimize sparking between collectors and conductors and to prevent undue wear on either the collectors or the conductors. The collector shall have two individually spring loaded contact shoes per conductor; shall be articulated, if necessary, to maintain full contact against the contact conductor; and shall be of graphite bronze or other suitable material as approved.

2.3.2.3 Festoon Conductors

****

NOTE: Use this paragraph if the trolley is to use a "Festoon" system. If this paragraph is used, delete paragraphs CONTACT CONDUCTORS and COLLECTORS above.

****

Power and control circuits may be brought to the crane trolley by means of a "festoon" system consisting of jacketed and color coded multiple conductor power and control cables which shall be bundled and supported by four-wheel trolleys running on "I" beam rails mounted on the inside of the main trolley girders. Trolley wheels shall be provided with antifriction bearings. The conductors of all cables shall be terminated at each end by terminal lugs connected to terminal blocks conforming to NEMA ICS 4mounted in cast iron junction boxes of NEMA Type 4 construction conforming to Part ICS-1-110 of NEMA ICS 1. Power and control circuits shall be segregated and terminated in separate junction boxes. Two extra conductors shall be provided in each control cable. All cable of a given "festoon" group shall be bundled together using nylon lacing material. All cables shall be supported with sufficient trolleys to maintain a minimum of 12 inchesfrom the top of the lifting beam.

2.3.3 Control Systems

A separate controller shall be provided for each motor; however, a duplex controller shall be used for two motor [bridge] [gantry] drives. Overload protection shall be in conformance with the requirements of NEMA ICS 2. Contactors that are used for starting, stopping, and reversing shall be mechanically and electrically interlocked.

2.3.3.1 Hoist Control System

****

NOTE: Select one paragraph for b. and delete the other paragraphs, see Additional Note E.

****

a. Motion Control - The main hoist [and auxiliary hoist] motion control system shall be [[single] [two] - speed, with AC magnetic control of AC squirrel cage motors] [five speed with AC magnetic control of AC wound rotor motor with [eddy current load] [mechanical load] [counter torque] braking] [AC static stepless control] [five speed with DC magnetic constant potential control] [DC variable voltage control].

[b. Motor Control - The hoist motor control system shall provide [one] [two] speeds in each direction by means of an electrically operated, full magnetic, across-the-line reversing starter. Electrical interlocks shall be used to prevent operation of all other speed contactors while the speed contactors for any one speed are energized.]

[b. Motor Control - The hoist motor control shall provide five-speed AC magnetic control of AC wound rotor motor with eddy-current braking. The eddy-current brake shall provide an adjustable varying artificial loading of the wound rotor hoist motor on at least two hoisting points and on four lowering points. Operation of the hoist shall be prevented upon loss of eddy-current brake excitation. Eddy-current brake shall be excited with reduced voltage when the hoist control is in the OFF position. There shall be positive drive down on all lowering points. On the first speed-point hoisting, the hook shall not lower with 100 percent of rated load and the no-load hook speed shall not exceed 30 percent of rated speed. On the first speed-point lowering, the full-load hook speed shall not exceed 18 percent of rated speed. As an additional feature, a self-excited alternator shall be mounted on the electric load brake housing to excite the load brake if the power supply fails.]

[b. Motor Control - The hoist motor control shall provide five-speed AC magnetic control of AC wound rotor motor with a mechanical load brake. The first point for hoisting shall provide not more than 45 percent of full-load motor torque. The first point lowering speed, with any load up to rated load, shall not exceed more than 40 percent of full-load hoisting speed. The second point lowering shall cause 75 percent of rated load to lower at not more than 30 percent of full-load hoisting speed.]

[b. Motor Control - The hoist motor control shall provide five-speed, counter torque control for wound rotor motors. When the control handle is in the last point lowering position there shall be a positive drive down of the hook or load to not less than synchronous speed nor more than 25 percent of synchronous speed with full rated load. This last point for lowering shall provide regenerative braking. All other lowering points shall provide speed retardation by the application of counter torque. The counter torque shall increase as the control handle is moved toward the NEUTRAL or OFF position. Counter torque secondary resistance control shall provide for not less than five manually held and one automatic speed point in each direction of motion. The first point for hoisting shall provide not more than 30 percent of full-load motor torque. The second point for hoisting shall provide not more than 60 percent of full-load motor torque.]

[b. Motor Control - The hoist motor control shall provide AC static stepless control. The control shall provide for continuously adjustable speeds throughout the range from minimum speed to maximum speed. Eddy-current braking shall provide a retarding torque for control of light loads in the hoisting direction and all loads in the lower direction of subsynchronous speed. To reduce holding brake wear, the control shall be arranged so that the electric load brake is effective in slowing the motion when the control is in the OFF position. The minimum hoist position of the control shall not allow the hook to lower with full rated load on the hook. Minimum lowering speed at rated hook load shall not exceed 15 percent of rated speed. Minimum speed hoisting with an empty hook shall not exceed 20 percent of synchronous motor speed. All loads up to 100 percent rated capacity shall raise on the minimum speed point of the master.]

[b. Motor Control - The hoist control system shall provide reversing, constant potential DC, five-speed, dynamic lowering, variable resistance, DC magnetic control of DC series wound hoist drive motors. The full-load lowering speed shall not exceed the following percentages of rated full-load hoisting speeds: 30 percent on first point; 205 percent on the fifth speed point. The first point hoisting shall provide not more than 20 percent of rated motor speed at no load motor torque, and zero speed (plus 5 percent, minus 0 percent of rated speed) at not less than 130 percent of rated motor torque. The second speed point hoisting shall not provide more than 50 percent of rated motor speed at no load motor torque. Emergency dynamic braking circuits shall be established when the motion control switch is in the OFF position and when the power supply is disrupted.]

[b. Motor Control - The hoist motor speed control shall provide DC stepless, speed regulated, adjustable voltage control of DC shunt wound motors. The control shall provide continuously adjustable speed from minimum speed to full speed. The minimum hoist position of the control shall not allow the hook to lower with 125 percent of full rated design load on the hook, and the minimum lower position of the control shall provide a full rated design load lowering speed at not more than 2 percent of rated speed. The control shall provide automatic regenerative braking for speed reduction and slow down before brake setting, and emergency dynamic braking when the control is in the OFF position and in case of power failure. The control shall provide a 50 to 1 speed range, with constant torque acceleration, for base and subbase speeds.]

2.3.3.2 Travel Control System

The [bridge] [gantry] and trolley motion control system shall be [[single] [two]-speed with AC magnetic control of squirrel cage motors] [three-speed with AC magnetic control of AC wound rotor motors] [AC static stepless control] [five-speed DC magnetic constant potential control] [DC variable voltage control].

[a. [Bridge] [Gantry] and Trolley Control - The [bridge] [gantry] and trolley main control systems shall provide [one] [two] speeds in each direction by means of an electrically operated, full magnetic, across-the-line reversing type starter. [Centrifugal switches shall be provided and used in the control circuit to prevent the plugging of trolley or [bridge] [gantry] drive motors; each switch shall be arranged to set the associated drive's brake while attempts are made to plug.] [The [bridge] [gantry] and] [trolley] main control system shall be provided with primary resistor reduced voltage starting, acceleration, and deceleration for all speed points.]]

[a. [Bridge] [Gantry] and Trolley Control - [Bridge] [Gantry] and trolley main control systems shall be AC magnetic control, [_____] speed, reversing, plugging type.]

[a. [Bridge] [Gantry] and Trolley Control - [Bridge] [Gantry] and trolley main control systems shall be AC static stepless. The control shall provide continuously adjustable speed from minimum to full speed. The minimum speed with zero hook load shall not exceed 10 percent of full rated speed. The control shall provide speed regulation of 15 percent or less from no load to full load at all speed settings.]

[a. [Bridge] [Gantry] and Trolley Control - [Bridge] [Gantry] and trolley main control systems shall be DC magnetic control, five speed, reversing, and plugging. The control shall provide automatic regenerative braking for speed reduction and slow down before brake setting when the control is in the OFF position and in case of power failure. The motor speeds, in percentages of rated full load motor speed, shall be: on the first point, not more than 12 percent; on the fifth point, not more than 105 percent; other points shall be evenly spaced between the first and fifth points. Acceleration between speed points shall be time delayed.]

[a. [Bridge] [Gantry] and Trolley Control - [The hoist motor speed control shall employ DC stepless, speed regulated, adjustable voltage control of DC shunt wound motors. The control shall provide continuous speed adjustment from minimum speed (10 percent at no hook load) to full speed. The control shall provide automatic regenerative braking for speed reduction and slow down before brake setting, and emergency dynamic braking when the control is in the OFF position and in case of power failure. The control shall provide a 50 to 1 speed range, with constant torque acceleration, for base and subbase speeds.]

****

NOTES: This is applicable to AC magnetic control of AC squirrel cage motor. If it is not desirable to have the motor immediately reverse direction, include sentence on plugging to allow the motor to stop prior to reversing direction. If excessive load swing cannot be tolerated during the start of the [bridge] [gantry] or trolley, include sentence on primary resistor reduced voltage starting.

Select the applicable paragraph and delete the other paragraphs; see Additional Note C.

****

b. Drift Point - With the master switch in the "Off" position, operation of a thumb-operated auxiliary switch in the operating lever shall actuate the drift position. In the "Drift" position, the electric brakes shall be released and the crane travel motor or motors de-energized to allow full control of drifting travel.

****

NOTE: If electric brakes are used, a drift point may be provided so the brakes will release after the motor is de-energized, thereby allowing the motion to coast and reducing swing of the load. A drift point can also allow the trolley to center itself over the load before actually starting to lift.

****

2.3.3.3 Magnetic Control Equipment

The primary and accelerating contactors and/or static devices shall be mounted on one or more panels and shall be enclosed in a cabinet or cabinets. The control circuits shall be wired to terminal blocks or studs complete and ready for making all external connections. Insulated wire shall conform to the requirements of paragraph CONDUIT AND WIRING. Magnetic contactors for individual motor controls shall have a rating the equivalent of the motor controlled, but in no case shall a contactor less than NEMA size 1 be used. The protective panel main line contactor shall be rated in accordance with NEMA ICS 3 for Service Class I, except that in no case shall the rating be less than one NEMA size greater than the largest individual motor contactor used.

2.3.3.4 DC Conversion Equipment

****
NOTE: See Additional Note F.
****

a. General - Each crane motion which requires independent operation shall be provided with a separate control and solid-state conversion unit except that a single solid-state conversion unit and set of control equipment may be used in event more than one gantry travel motors is provided.

b. Solid-State Conversion Unit - The power conversion system for each motion shall be solid-state, silicon-controlled rectifier or thyristor with adequate capacity to drive its connected DC motor or motors at all specified speeds and loads. The conversion unit (including overload protection) shall be rated for continuous duty at the motor current necessary to lift 150 percent rated load at any speed point, and shall have a 1-minute rating equal to the necessary current to develop a motor torque corresponding to 200 percent of rated load. Rectifier elements shall be hermetically sealed and mounted on heat sinks cooled by natural convection, except that forced-air cooling may be used if over-temperature protection is provided for the rectifiers. Forced-air cooled units must be capable of delivering full-load without damage for not less than 5 minutes following loss of the cooling. The rectifier system shall be built, installed, and enclosed in accordance with [EIA 397 and EIA 397-1] [IEEE 597] [_____]. Minimum protection shall consist of line isolating transformers, transient voltage and current surge suppressors [conforming to UL 1449], and either current-limiting rectifier fuses or static instantaneous overcurrent circuits with sensing in each phase of the AC line. Individual Thyristors shall be with ultrafast current-limiting rectifier fuses and shall be provided with failure indication. The control circuit shall include an adjustable-operating current limit circuit capable of limiting maximum current to not more than the current necessary to obtain 200 percent motor torque. The repetitive peak inverse voltage rating of the rectifier shall be not less than 250 percent of the working peak inverse voltage. Thyristor case temperature shall not exceed 100 degrees C in a 30 degrees C ambient when delivering rate load. When parallel operation of thyristors is required, each unit's actual share of the load shall not differ from its calculated share by more than 10 percent. Purposely matched units shall not be used. Parallel operation of thyristors will not permitted for individual loads less than 235 amperes RMS. The firing pulse for paralleled thyristors shall have a rise time less than 0.5 microsecond and a peak gate current not less than 1.5 amperes. The firing pulse for nonparalleled thyristors shall have a rise time less than 1 microsecond and a peak gate current not less than 1 ampere for all devices rated above 35 amperes RMS. The maximum value of the DC average voltage output shall not exceed 500 volts.

2.3.3.5 Control Panels

****
NOTE: Control panel heaters are desirable for outdoor cranes and cranes in air conditioned spaces, especially static controls.
****

Control panels shall be fabricated of solid sheet steel designed and constructed to conform to the requirements of NEMA ICS 6 Type [_____]. [Thermostatically controlled heaters shall be provided in each panel.] Control panel doors shall be hinged, equipped with gaskets, and shall be fitted with key-lock handles designed to latch the door at top, center, and bottom. A single key shall open all locks.

2.3.3.6 Pendant Control Station

****

NOTE: If pendant control is not specified, delete this paragraph.

****

a. Design - The pendant control station shall be suspended from the crane by a strain chain or 1/4 inch (minimum) wire rope strain lead of corrosion resistant steel. The pendant station shall be attached to the underside of [the crane [bridge] [gantry] footwalk] [an auxiliary girder]. The pendant control station enclosure shall be NEMA Type [4] [7] [9] in accordance with NEMA ICS 6. Pushbuttons shall be heavy duty, dust-and-oil-tight type having distinctly felt operating positions. Pushbuttons shall be so constructed that they cannot become hung-up in the control case. Pendant shall include a separate set of pushbuttons for each motion and for POWER ON-POWER OFF. [One yellow pilot light to indicate excessive hoist motor temperature shall be provided on the pendant station.] A blue pilot light to indicate that the main contactor is energized and a white pilot light to indicate that power is available on the load side of the crane disconnect switch shall also be provided. The POWER OFF pushbutton shall have a bright red mushroom head. Operating pushbuttons and pilot lights shall meet the heavy-duty requirements of NEMA ICS 2. Pushbuttons shall be as follows:

****

NOTE: Provide [bridge] [gantry] and trolley directions normally oriented to main compass headings. Select method of festoon suspension: For multiple girder cranes select underneath footwalk and for single-girder cranes select auxiliary girder. If a hoist thermal sensor is specified, include requirement for yellow pilot light.

****

Hoist - up
Hoist - down
[Bridge] [Gantry] - [_____]
[Bridge] [Gantry] - [_____]
Trolley - [_____]
Trolley - [_____]
POWER OFF
POWER ON
[Auxiliary Hoist - up]
[Auxiliary Hoist - down]

b. Pendant Drive Control - three-position momentary contact spring return to OFF toggle switch shall be provided to control the motorized trolley for the pendant.

c. Pendant Festoon System - The pendant festoon system shall consist of a support rail, flat cables, junction boxes, cable cars, and accessories. All hardware shall be corrosion resistant. Cable loops shall not drop below the hook high position. The pendant control car shall be provided with NEMA Type 4 junction box. The pendant festoon shall be [towed by the trolley] [independent of trolley motion].

d. Pendant Drive System - The pendant festoon system shall be provided with a motor drive system capable of driving the pendant control car at [_____] fpm. The pendant motor drive shall be controlled from the pendant.

****

NOTE: If the crane is higher than 18 meters (60 feet) above the operating floor and the span is greater than 15 meters (50 feet), consider including a pendant drive for ease of movement of the pendant if it is not towed by the trolley; otherwise delete this paragraph. Pendant drive speed should be the same as the trolley.

****

e. Pendant Retraction System - [The pendant control car shall be provided with an electric powered cable reel such that the pendant station may be retracted fully.] [The cable reel shall only be required to hoist the strain lead to retract the pendant station.]

****

NOTE: Select method of pendant retraction if specified, otherwise delete paragraph.

****

2.3.3.7 Protection

a. Main Line Disconnect - A main line disconnect consisting of a combination circuit breaker and nonreversing starter (main line contactor) in NEMA Type [_____] enclosure shall be provided. The main line disconnect shall be controlled by a control circuit such that all crane motions shall be stopped upon main line undervoltage, overload, control circuit fuse failure, or operation of the POWER OFF pushbutton.

b. Circuit Breakers - Circuit breakers shall meet the requirements of UL 489 and NEMA AB 1.

c. Overloads - [AC circuit overload relays shall be of the ambient compensated, automatic reset, inverse time type located in all phases of the main line and individual motor circuits and arranged to open the main line contactor.] [An automatically reset inverse time trip running overload relay shall be provided for each DC motor circuit. In addition, an automatically reset instantaneous trip overload relay in each DC motor circuit or for a pair of motors shall be provided. The overload relays shall be arranged to de-energize the associated motor on an overload condition.]

****

NOTE: Select applicable overload protection based on control circuit type.

****

2.3.3.8 Limit Switches

Limit switches shall be heavy duty quick-break double-pole double-throw type and shall conform to NEMA ICS 2. Geared limit switch interruption of a motion in one direction shall not prevent the opposite motion. Geared limit switches shall reset automatically. Limit switch housings shall be NEMA Type [_____]. Limit switches shall interrupt power to the control systems.

a. Hoist Upper Limit Switches - Two limit switches shall be provided for each hoist. A rotating adjustable geared control circuit interrupt limit switch shall provide hoist-up limiting. A secondary hoist upper limit shall be provided with a weight operated limit switch, to prevent raising beyond their safe limit. This secondary limit switch shall operate to interrupt power to all hoist motor conductors and set the hoist holding brakes.

b. Hoist Lower Limit Switches - Hoists shall be provided with a rotating adjustable geared control circuit interrupt limit switch for hoist-down travel limiting.

c. [Bridge] [Gantry] and Trolley Travel Limit Switches - Runway (track) limit switches shall be mounted to the crane [bridge] [gantry] and trolley, respectively, adjacent to one runway rail to interrupt current to the [bridge] [gantry] and trolley controls. Adjustable limit switch actuators shall be installed on both ends of those rails to actuate the limit switches and stop the crane [bridge] [gantry] or trolley prior to contacting the runway bumpers.

****

NOTE: Specify [bridge] [gantry] and trolley limit switches if critical loads are handled or for other special requirements.

****

d. Rail Clamp Limit Switches - Each rail clamp shall be furnished with a limit switch designed to interrupt the control circuits to the [bridge] [gantry] drive when the rail clamps are set. A red pilot light shall be provided at the control station to indicate the rail clamps are set.

****

NOTE: Include paragraph for outdoor cranes, otherwise delete.

****

2.3.3.9 Warning Horn

A solid state electronic warning horn shall be provided on the crane. Any [bridge] [gantry] or trolley motion shall be accompanied by a continuous series of alternating tones.

2.3.3.10 Wind Indication and Alarm

****

NOTE: Specify location of wind alarm station for outdoor cranes, normally mounted near center of the

[bridge] [gantry]. Provide location of cutout. Delete paragraph if not applicable.
****

A wind indicating device with an adjustable alarm trip point shall be provided. The adjustable trip shall actuate an oscillating blue light and bell mounted near [_____]. The bell shall have the ability to be cut out from the pendant station.

2.3.3.11 Load Limit System

****
NOTE: Specify load sensing if loads approaching the capacity of the crane are to be lifted routinely.
****

A load limit system shall be provided for the main hoist. The primary purpose of the load limit system is to inform the operator by an alarm that the preset load has been exceeded. The system shall consist of a load cell, load sensing electronics, no-load and overload indicator lights, overload alarm bell, and alarm cut-out switch. The load cell shall be mounted to receive the load from the axle of the equalizing sheave. The alarm setpoint shall be adjustable.

2.3.4 Motors

2.3.4.1 General Requirements

****
NOTE: See Additional Note G.
****

Motors shall be designed specifically for cranes and hoist duty. Drain holes shall be provided at low points near each end. Inspection and service covers shall be provided with gaskets. All hardware shall be corrosion resistant. Motors shall conform to the requirements of NFPA 70, [NEMA MG 1] and UL 1004. [Motors shall be provided with a suitable heater to prevent condensation during long periods of inactivity.] One thermal sensitive device embedded in the hoist motor windings shall be provided. The device and associated circuitry shall serve as an alarm activating a yellow pilot light [at the control stations] when motor temperatures become excessive. The set point shall be set below the Class B insulation temperature limit. The thermal-sensitive device and associated circuits shall be self-restoring (automatic reset).

2.3.4.2 Main [and Auxiliary] Hoist Motor

The hoist motor shall be [industrial] [mill] [[single-speed; single-winding] [two-speed; two-winding]] [NEMA design D squirrel cage AC] [wound rotor AC induction] [AC designed for use in static stepless control systems] [DC series wound] [DC shunt wound].

2.3.4.3 [Bridge] [Gantry] and Trolley Drive Motors

The [bridge] [gantry] and trolley drive motors shall be [industrial] [mill] [single-speed; single-winding] [two-speed; two-winding] [NEMA design B squirrel cage AC rated] [wound rotor AC induction] [AC designed for static stepless operation] [DC series wound] [DC shunt wound].

2.3.4.4   Motor Enclosures

****
NOTE: a. Select drip-proof enclosure for indoor usage, except in a hazardous atmosphere.

b. Select totally enclosed nonventilated enclosure for outdoor use and indoor use in a hazardous atmosphere.

c. Select totally enclosed fan cooled enclosure for motors operating at rated speed for long periods.

d. Select forced ventilated enclosure for Class E service.
****

Motor enclosures shall be [totally enclosed, nonventilated (TENV)] [totally enclosed, fan cooled (TEFC)] [drip-proof] [drip-proof forced ventilated].

2.3.4.5   Hoist Motor Insulation and Time Rating

****
NOTE: See Additional Note H.
****

The hoist motors shall be provided with Class [B] [F] [F or H] insulation with a [30] [60]-minute minimum motor time rating to satisfy NEMA permissible motor temperature rise above 40 degrees C ambient [permitted by Class B insulation].

2.3.4.6   [Bridge] [Gantry] and Trolley Motor Insulation and Tim e Rating

The [bridge] [gantry] and trolley drive motors shall be provided with Class [B] [F] [F or H] insulation with a [30] [60]-minute minimum motor time rating to satisfy NEMA permissible motor temperature rise above 40 degrees C ambient [permitted by Class B insulation].

2.3.5   Electric Brakes

2.3.5.1   Hoist Brake Time Delay

****
NOTE: Delete this paragraph if one brake is specified.
****

One of the hoist holding brakes shall be provided with a time delay setting (from 1 to 3 seconds). Such time delay shall be initiated upon release of the control pushbutton or return of the master switch to OFF.

2.3.5.2   Automatic Stop System

All electrically controlled brakes shall be applied automatically when power is interrupted. Brakes shall be wired so that the brakes release upon operation of a pushbutton for the associated drive and shall set upon release of that pushbutton, return of the master switch to OFF, operation of POWER OFF pushbutton, de-energization of main line contactor, or power failure. Electric brakes shall be designed so that they can be mechanically released. Enclosures for brake electrical components shall be NEMA ICS 6. DC shunt magnetic shoe brakes shall be provided with an electrical forcing circuit for rapid release of the brake. Each shunt coil brake shall be circuited so that both conductors supplying the brake are opened simultaneously when the brake is de-energized.

2.3.6 Lighting Heating and Convenience Outlets

****

NOTE: If lighting, motor, or control cabinet heaters or receptacles are specified, this paragraph shall be included if 460-volt AC is the power source. Select the components requiring power.

****

Three-phase 208Y/120-volt AC power, supplied via a circuit breaker [and isolation transformer] conforming with NEMA ST 1 from the line side of the main line disconnect shall be used for [lighting,] [heaters,] [and accessory circuits] on the crane. The circuit breaker shall have a NEMA [_____] enclosure in accordance with NEMA ICS 6. The enclosure shall have provisions to lock the breaker in the OFF position. Each pole of the circuit breaker shall have individual thermal and magnetic trip elements; a button shall be provided on the enclosure cover for mechanically tripping the circuit breaker. A three-phase 480-volt delta primary, and 208Y/120-volt wye secondary general lighting isolation transformer shall be fed from the accessory circuit breaker and shall feed a 208Y/120-volt UL listed circuit breaker panelboard [and a heater circuit breaker/combination starter]. The panelboard shall supply branch circuits for utilization of various accessories such as [receptacles,] [lighting] [and panel internal lighting].

2.3.6.1 Transformers

Transformers shall be dry type and shall carry full load continuously at rated voltage and frequency without exceeding an average temperature rise of 115 degrees C above an ambient temperature of 40 degrees C. The transformer shall have a totally enclosed case which shall be finished with manufacturer's standard coating system. Transformers shall be fully encapsulated, except for those specifically designed for use as an isolation transformer for static power conversion units.

2.3.6.2 Receptacles

****

NOTE: Specify receptacles for multiple-girder cranes. Specify ground fault protection for outside cranes.

****

Receptacles shall be, single-phase, 120-volt 15-amp, grounded, duplex with metal NEMA [_____] enclosure with self-closing weather-proof receptacle cover. A receptacle shall be provided on each end of the [bridge] [gantry] walkway, on the trolley, in the vicinity of [bridge] [gantry] travel drive motors. Several receptacles shall be provided in the vicinity of the control equipment equally spaced every 5 feet. [Breakers used to protect circuits supplying receptacles shall incorporate ground fault current interruption feature and meet the requirements of UL 943.]

2.3.6.3 Lighting

****
NOTE: Specify lighting for outdoor cranes or in dimly lit areas.
****

A circuit breaker, lighting transformer, and panelboard shall be provided for general lighting. Control panels shall be provided with a 120-volt lamp with an unbreakable lens and switch. Floodlights shall be provided to illuminate the work area under the crane, and the drum area on the crane and shall be controlled from the crane control station. Floodlight fixtures shall be attached to the underside of the crane and spaced for uniform lighting. Floodlights shall be metal halide, industrial luminaries. Each floodlight shall be totally enclosed, vapor tight design, gasketed, and have a heat- and impact-resistant glass lens.

2.3.6.4 Anticondensation Heaters

****
NOTE: Motor heaters recommended for outdoor cranes or cranes in air conditioned spaces; if not desired delete this paragraph.
****

All motors [and control panels] shall be equipped with thermostatically controlled anticondensation heaters. The circuit breaker combination magnetic starter shall be NEMA [_____] enclosure in accordance with NEMA ICS 6. The magnetic starter shall be equipped with manually reset overload relays and shall be interlocked with the main line disconnect so that all anticondensation heaters are de-energized when the main line disconnect is energized; and shall be energized when the main line disconnect is de-energized.

2.3.7 Conduit and Wiring

2.3.7.1 General

All wiring between equipment units or components, except where flexible connections are specified, shall be installed in rigid, steel conduit with threaded condulet fittings and zinc-coated NEMA [_____] outlet and pull boxes. Conduit connections to motors, brakes, limit switches, wheel trucks, and other items where flexible connections are required shall be made using short lengths of liquid-tight flexible conduit. The conduit shall be securely mounted and fastened to the crane framework and shall be installed in a neat and workmanlike manner. Change of direction of a conduit run shall be made by means of threaded condulet fittings and the conduit shall be installed to fit close to the crane framework. Conduit unions shall be used where standard couplings cannot be used to join conduits or as required to permit dismantling for shipment. No running threads will be permitted. Ends of conduits shall be carefully reamed.

All threaded connections shall be made up with a compound composed of colloidal copy and rust inhibitors. Separate conduit systems shall be provided for power, control, and lighting circuits. The entire conduit system shall be grounded and shall be installed so that any moisture will be drained from terminal boxes and equipment. All conduit connections to equipment enclosures shall be watertight threaded. Suitable "drain-breather" devices shall be provided at all low points of the conduit system to allow water to escape continuously. The conduit system shall be installed in the shop, complete and ready for installing wire and after inspection shall be dismantled as necessary for shipment to the site.

2.3.7.2 Conduit

a. Rigid Conduit - Rigid steel conduit shall conform to ANSI C80.1 and shall, in addition, be zinc-coated (galvanized) both inside and outside by the hot-dip method.

b. Flexible Conduit - Flexible conduit shall conform to CID A-A-55810, shall have a hot-dipped galvanized steel core, copper ground wire, and a waterproof extruded PVC cover.

2.3.7.3 Insulated Wire and Cable

a. Materials, Construction and Tests - Materials, construction, and tests, unless otherwise specified, shall conform to the applicable requirements of NEMA WC 7 or NEMA WC 8, as applicable. Parts, tables, sections, appendices, grades, and classes specified will refer to the above NEMA standards, unless otherwise stated.

b. Conductors - Conductors shall be annealed copper wire. Copper conductors shall be tin or lead alloy coated, or bare, as required by the type of insulation used. All conductors shall have class B or C standing. Solid conductors will not be permitted.

c. Insulation

(1) Material

Insulation shall be a cross-linked polyethylene meeting the dimensional, electrical, and physical requirements of Part 3 of NEMA WC 7 or NEMA WC 8. Type I or Type II grade of EPR insulation shall be used for single-conductor cables with a jacket and for the individual conductors of a multiple-conductor cable with an overall jacket.

(2) Insulation Thickness

Insulation thickness shall be as required by Table 3-1, Part 3 of NEMA WC 7 or NEMA WC 8 as applicable, for rated circuit voltage of 0-600 volts. Single-conductor cross-linked polyethylene insulated cables with Column A thickness only will be permitted without a jacket. Single-conductor ethylene-propylene-rubber insulated conductors with Column A thickness will not be permitted.

d. Type - Unless otherwise specified or approved, all wire and cable for power, control, and lighting shall be single conductor.

e. Jackets - An outer jacket of a synthetic thermosetting material shall be applied over multiple-conductor cables. Single-conductor cables and individual conductors of a multiple-conductor cable may have a jacket. The jacket shall be tightly and concentrically formed around the core of the cable. Single-conductor cables shall have jackets when insulation thickness is in accordance with Column B, Table 3-1, Part 3 of NEMA WC 7 or NEMA WC 8. The jacket shall be a synthetic thermosetting compound and shall conform to one of the following:

(1) Heavy-duty black neoprene in accordance with paragraph 4.4.3 of NEMA WC 8.

(2) Heavy-duty black chlorosulfonated polyethylene in accordance with paragraph 4.4.9 of NEMA WC 8.

f. Dimensional Tolerance - The outside diameter of single-conductor wires and cables shall not vary more than 5 percent from the calculated outside diameter based on the thickness, including tolerance, of the component materials specified.

g. Wires - Near resistors, wiring exposed to heat shall have flame retardant, heat and moisture resistant insulation, and conform to the requirements of NFPA 70 and the following: Maximum operating temperature for conductors generally shall be 90 degrees C except that maximum operating temperature for internal wiring conductors in resistor cabinets shall be 125 degrees C.

h. Control Panel Wiring - Control panel wiring shall be stranded copper switchboard wire with 600-volt insulation and except for type SIS shall be coated. The wire shall be AVB or SIS. Hinge wire shall have Class K stranding. Hinge wire shall be used between stationary and hinged equipment and shall be formed in wire loops or bundles at least 2 feet long which shall provide rotation around the longitudinal axis of the conductors.

i. Festoon System Cable - The connections to the trolley shall be made using type G cables with 75 degrees C, 600-volt insulation and heavy-duty "Neoprene" jacket for the power circuits and type SO cord with 60 degrees C, 600-volt insulation and "Neoprene" jacket for control and lighting circuits. Type G cables and SO cords shall conform to the applicable requirements of NEMA WC 3, Part 7, paragraphs 7.6 and 7.7, respectively. Conductors shall have not less than class H stranding.

j. Current Carrying Capacity - Wire for power and motor circuits shall have a current carrying capacity of not less than the full-load current of the motor or the circuit but in no case less than No. 10 AWG. Wire for control circuits shall not be smaller than No. 14 AWG. Wires exposed to heat or in resistor cabinets shall be sized as required but in no case less than No. 10 AWG.

k. Terminations and Continuity - All conductor connections, except for splices in lighting conductors which are made in junction boxes, shall be terminated at terminal studs or terminal blocks using approved indented terminal ring-tongue connectors. All screw terminals shall have lockwashers and all stud terminals shall have contact nuts and either locking nuts or lock washers. Splices will be permitted only in accordance with NFPA 70.

2.3.8 Fungus Resistance

Electrical connections, such as terminal and circuit connections, components and circuit elements, shall be coated with fungus-resistant varnish except that components and elements inherently inert to fungi or hermetically sealed need not be treated; components and elements whose operation will be adversely affected by the application of varnish shall not be treated.

****
NOTE: Specify fungus resistance for cranes in marine or humid environments.
****

PART 3 EXECUTION

3.1 SHOP ASSEMBLY AND TESTS

The hoists, trolleys, trolley drives, and gantry drives shall be shop assembled and operated under their own power. Reeving of drums and sheaves will not be required. Permanent wiring except wire which would be disassembled or partly disassembled for shipment shall be installed. Permanent conduit except conduit attached to walkways, ladders, stairs, and machinery housing shall be installed. The [bridge] [gantry] structural frame shall be assembled and checked for fit and alignment. The test shall demonstrate that the various parts and components are correctly fabricated, assembled, and fitted. The Contractor shall notify the Contracting Officer [____] days prior to testing operations.

3.2 PREPARATION FOR SHIPMENT

After completion of the shop tests, the crane shall be match-marked and prepared for shipment with electrical connections tagged. Four copies of a diagram of match-marks shall be furnished. All parts and equipment at the site shall be protected from weather, damage, abuse, and loss of identification.

3.3 ERECTION

Erection shall be in accordance with the manufacturer's instructions and as indicated.

3.3.1 Erection Procedures

Major components of the crane shall be shop assembled as completely as possible. The erection procedures shall ensure that the crane is erected without initial stresses, forced or improvised fits, misalignments, nicks of high-strength structural steel components, stress-raising welds, and rough burrs. After the crane is erected, any damaged painted surfaces shall be cleaned and repainted. After erection is complete, the equipment shall be serviced. All necessary grease and oil of approved quality and grade for the initial servicing and field test shall be provided by the Contractor.

3.3.2 Mechanical Alignment

All motors, couplings, brakes gear boxes, and drive components shall be aligned when reinstalled, in accordance with manufacturer's instructions.

3.3.3 Electrical Alignment

The control system shall be aligned in accordance with manufacturer's instructions. Alignment data shall include timer settings, resistor tap settings, potentiometer settings, test point voltages, supply voltages, motor voltages, motor currents, and test conditions such as ambient temperature, motor load, date performed, and person performing the alignment. A copy of the final alignment data shall be stored in control panel door.

3.3.4 Field Painting

****
NOTE: Specify field painting desired for crane.
****

Painting required for surfaces not otherwise specified and finish painting of items only primed at the facility shall be as specified in Section 09965 PAINTING: HYDRAULIC STRUCTURES.

3.4 ACCEPTANCE TESTING

3.4.1 Crane Test

The Contractor shall provide all personnel necessary to conduct the tests including but not limited to crane operators, riggers, rigging gear, and test weights. Testing shall be performed in the presence of Contracting Officer. The Contractor shall notify the Contracting Officer [_____] days prior to testing operations.

3.4.1.1 Test Sequence

The crane shall be tested according to the applicable paragraphs of this procedure in the sequence provided.

3.4.1.2 Test Data

Operating and startup current measurements shall be recorded for electrical equipment (motors and coils) using appropriate instrumentation. Speed measurements shall be recorded as required by the facility evaluation tests (normally at 100 percent load). Recorded values shall be compared with design specifications or manufacturer's recommended values; abnormal differences shall be explained in the remarks and submitted for approval or appropriate adjustments performed. In addition, high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated, and corrected. Hoist, trolley, and [bridge] [gantry] speeds should be recorded during each test cycle.

3.4.1.3 Equipment Monitoring

During the load test, improper operation or poor condition of safety devices, electrical components, mechanical equipment, and structural assemblies shall be monitored. Observed defects critical to continued testing shall be reported immediately to the Contracting Officer, and testing shall be suspended until the deficiency is corrected. During and immediately following each load test, the following inspections shall be made:

a. Inspect for evidence of bending, warping, permanent deformation, cracking, or malfunction of structural components.

b. Inspect for evidence of slippage in wire rope sockets and fittings.

c. Check for overheating in brake operation; check for proper stopping. All safety devices, including emergency stop switches and POWER OFF pushbuttons, shall be tested and inspected separately to verify proper operation of the brakes.

d. Check for abnormal noise or vibration and overheating in machinery drive components.

e. Check wire rope sheaves and drum spooling for proper operation, freedom of movement, abnormal noise, or vibration.

f. Check electrical drive components for proper operation, freedom from chatter, noise, or overheating.

g. Inspect external gears for abnormal wear patterns, damage, or inadequate lubrication.

3.4.1.4 Hooks

Hooks shall be measured for hook throat spread before and after load test. A throat dimension base measurement shall be established by installing two tram points and measuring the distance between these tram points (to within 1/64 inch.) This base dimension shall be recorded. The distance between tram points shall be measured before and after load test. An increase in the throat opening by more than 1 percent from the base measurement shall be cause for rejection.

3.4.2 No-Load Testing

3.4.2.1 Hoist Operating and Limit Switch Test

The load hook shall be raised and lowered through the full range of normal travel at rated speed and other speeds of the crane. The load hook shall be stopped below the geared limit switch upper setting. In slow speed only, proper operation of upper and lower limit switches shall be verified. The test shall be repeated a sufficient number of times (minimum of three) to demonstrate proper operation. Brake action shall be tested in each direction. The proper time delay shall be verified between the actuation of the dual brakes.

3.4.2.2 Trolley Travel

The trolley shall be operated the full distance of the [bridge] [gantry] rails exercising all drive speed controls in each direction. Brake operation shall be verified in each direction. In slow speed the trolley bumpers shall contact the trolley stops located on the [bridge] [gantry] girders.

3.4.2.3 [Bridge] [Gantry] Travel

The [bridge] [gantry] shall be operated the full distance of the runway exercising all drive speed controls, in each direction. Brake operation shall be verified in each direction. In slow speed, the proper operation (interrupt power, automatic reset) of the [bridge] [gantry] limit switches at both limits of [bridge] [gantry] motion shall be tested. In slow speed, the crane [bridge] [gantry] bumpers shall contact the runway rail stops.

3.4.2.4 Hoist Loss of Power No-Load Test

The hooks shall be raised to a height of approximately 12 feet or less.

While slowly lowering the hook, the main power source shall be disconnected verifying that the hook will not lower and that both brakes will set.

3.4.2.5 Travel Loss of Power No-Load Test

With the hook raised to clear obstructions and the trolley traveling in slow speed, the main power source shall be disconnected verifying that the trolley will stop and that the brake will set. The test shall be repeated for the [bridge] [gantry] slow speed drive controls.

3.4.3 Load Test

3.4.3.1 Hoist

Unless otherwise indicated, the following tests shall be performed using a test load of 125 percent of rated load.

a. Hoist Static Load Test: Holding brakes and hoisting components shall be tested by raising the test load approximately 1 foot and manually releasing one of the holding brakes. The load shall be held for 10 minutes. The first holding brake shall be reapplied and the second holding brake released. The load shall be held for 10 minutes. Any lowering that may occur indicates a malfunction of the brakes or lowering components.

b. Dynamic Load Test: The test load shall be raised and lowered at each speed through the full operating range. The machinery shall be completely stopped at least once in each direction to ensure proper brake operation.

c. Hoist Load Brake: With test load raised approximately 5 feet and with the hoist controller in the neutral position, the holding brake shall be released. The load brake shall be capable of holding the test load. With the holding brake in the released position, the test load shall be lowered (first point) and the controller shall be returned to OFF position as the test load lowers. The load brake shall prevent the test load from accelerating.

d. Hoist Loss of Power Test: After raising the test load to approximately 8 feet, begin slowly lowering the test load, the main power source and the control pushbutton shall be released verifying that the test load will not lower and that both brakes will set.

e. Trolley Dynamic Load Test: While operating the trolley the full distance of the [bridge] [gantry] rails in each direction with test load on the hook (one cycle), the proper function of all speed control points and proper brake action shall be tested.

f. [Bridge] [Gantry] Dynamic Load Test: With test load on the hook, the [bridge] [gantry] shall be operated for the full length of the runway in both directions with the trolley at each extreme end of the [bridge] [gantry]. Proper function of all drive speed control points and brake action shall be verified. Binding of the [bridge] [gantry] end trucks shall indicate malfunction.

3.4.3.2 Trolley and [Bridge] [Gantry] Loss of Power Test

Using a test load of 100 percent of rated load, the load shall be raised clear of any obstructions on the operating floor. Starting at a safe distance from walls or other obstructions, a slow speed shall be selected using the trolley and [bridge] [gantry] drive. While maintaining a safe distance to obstructions, the main power source shall be disconnected and the brakes shall be verified to have set and that the equipment stops within the distance recommended by the manufacturer.

3.5 FRAMED INSTRUCTIONS

Framed instructions under acrylic plastic or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

3.6 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, erection, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.7 FIELD TRAINING

A field training course shall be provided for designated operating staff members. Training shall be provided for a total period of [_____] hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance instructions. The Contracting Officer shall be given at least 2 weeks advance notice of such training.

3.8 SPARE PARTS

One set of manufacturer's recommended spare parts shall be furnished and delivered to the site. The spare parts shall be suitably packaged for long-term protection and storage. The packaging shall be legibly labeled to identify the spare parts. A list of the furnished spare parts shall be included in the Maintenance manual.

****

ADDITIONAL NOTES

NOTE A: For additional information on the use of all CEGS, see CEGS GENERAL NOTES.

NOTE B: Crane types covered are top-running [bridge] [gantry] and trolley, multiple-girder, with MHI CMAA 70 service class of A through E. Control types and systems may be specified.

Control Systems: AC or DC can be specified.

Crane Terminology:

a. Top-running [bridge] [gantry] is a [bridge] [gantry] which travels on the top surface of rails of a fixed runway structure.

b. Top-running Trolley is a trolley which travels on the top surfaces of rails of the [bridge] [gantry] girder(s).

Overhead or Gantry: Throughout the guide specification is the following: "[bridge] [gantry]". For an overhead crane, select "bridge" and for a gantry crane, select "gantry".

NOTE C: Provide service classification. MHI CMAA 70 service classifications are:

Class A (Standby or Infrequent Service)
Class B (Light Service)
Class C (Moderate Service)
Class D (Heavy Duty)
Class E (Severe Service)

Select type environment using guidance from NFPA 70.

NOTE D: Provide rated speed under full load for the main hoist, auxiliary hoist (if specified) [bridge] [gantry] and trolley. In the following tabulations, the slow speeds apply to Class A and B service, the medium speeds to Class C and D service, and the fast speeds to Class E service. Speeds are in millimeters per second or feet per minute.

FLOOR OPERATED INDUSTRIAL CRANES
(millimeters per second)

RATED	HOIST			TROLLEY			[BRIDGE][GANTRY]		
LOAD	Slow	Med	Fast	Slow	Med	Fast	Slow	Med	Fast
4.5	100	150	250	250	375	500	500	750	875
9.1	75	125	175	250	375	500	500	750	875
13.6	75	100	125	250	375	500	500	750	875
18.1	75	100	125	250	375	500	500	750	875
22.7	50	100	125	250	375	500	375	500	750
27.2	50	75	125	250	375	500	375	500	750

FLOOR OPERATED INDUSTRIAL CRANES
(feet per minute)

RATED	HOIST			TROLLEY			[BRIDGE][GANTRY]		
LOAD	Slow	Med	Fast	Slow	Med	Fast	Slow	Med	Fast
5	20	30	50	50	75	100	100	150	175
10	15	25	35	50	75	100	100	150	175
15	15	20	25	50	75	100	100	150	175

FLOOR OPERATED INDUSTRIAL CRANES
(feet per minute)

RATED	HOIST			TROLLEY			[BRIDGE][GANTRY]		
LOAD	Slow	Med	Fast	Slow	Med	Fast	Slow	Med	Fast
20	15	20	25	50	75	100	100	150	175
25	10	20	25	50	75	100	75	100	150
30	10	15	25	50	75	100	75	100	150

Auxiliary hoist may be specified for handling light loads (typically 10 to 30 percent of main hoist rated load) at two to four times the main hoist speed.

NOTE E: Select desired control system design. Depending on application, it may be desirable to select different control systems for the hoist and travel in order to obtain the desired control characteristics. Delete the unused paragraphs for main and auxiliary hoist control.

AC Magnetic Control, AC Squirrel Cage Motors Squirrel cage motors have only limited usefulness on cranes. Application is limited to light-duty weight handling service requiring not more than about 15 kW (20 HP) motors. These motors are used where hook or travel speed is slow, operation is by unskilled personnel, and elaborate speed control and accurate positioning of the load is not required. The main advantage of selection of this control and motor arrangement is low cost and simple maintenance for light capacity cranes.

AC Magnetic Control, AC Wound Rotor Motors AC wound rotor motors with AC magnetic controls are well suited for high-capacity weight handling service (heavy-duty crane with large motors). AC magnetic control with AC wound rotor motors is generally used when there is a restricted range of speed and load, and there are no requirements for precision handling.

AC Stepless Control, AC Wound Rotor Motors Control of the system is essentially stepless and fine control is provided. Speed is determined by the master switch setting independent of the load weight. Static stepless control is not suited for extended low speed operation. Static control is normally specified when precise speed control is required.

DC Magnetic Control, DC Series Wound Motors DC series wound motors with DC magnetic control are usually used in rugged-duty (class E cranes) applications where severe service and large size motors are found. All DC cranes should be equipped with one or more holding brakes (two for hoist motion).

DC Stepless Control, DC Shunt Wound Motors DC stepless control uses DC shunt wound motors and a static conversion unit to convert AC power to DC for motor and control system use. This type of control system can provide stepless speed control with smooth acceleration and deceleration, fast no-load hook speed, much less motor heating during extended low-speed operation, and very accurate positioning.

Hoist Control Selection

a. An AC wound rotor motor with AC magnetic control, reversing, with mechanical load brake. This type of control is the least expensive control. Good positioning and landing speeds are inherently available for only a fraction of the loads, and jogging must be heavily relied upon. This type of control should be used only for rough (nonprecision) handling situations.

b. An AC wound rotor motor with AC magnetic control, reversing, with automatically controlled eddy-current brake. The eddy-current brake provides a load on the motor at all times permitting excellent speed regulating properties. This control is suitable for applications requiring accurate positioning of loads in both the hoisting and lowering positions. This control is suitable for heavy-duty, accurate speed control, intermediate speed, precision handling applications.

c. An AC wound rotor motor with AC magnetic control, reversing, countertorque control braking means. This control system is commonly used for severe weight handling service (i.e., Class E service). THE CONTROL IS ONLY SUITED TO THOSE APPLICATIONS WHERE AT LEAST 50 PERCENT RATED LOAD IS ON THE ROPES AT ALL TIMES. If the hoist is operated in lower mode without a substantial load, the load may actually go up instead of down.

Travel Control Selection

An AC wound rotor motor with AC magnetic control, three to five speed, reversing, plugging type. This type of control provides smooth acceleration under rated load. The [bridge] [gantry] or trolley will accelerate almost to full speed with light loads, regardless of control point selected.

NOTE F:

a. Select applicable DC control system.

b. If DC control system specified includes sentence concerning control rectifiers.

c. Include thyristors, if DC static stepless specified, otherwise delete.

d. Delete requirement for rectifier [bridge] [gantry] if AC control systems are used.

Select protective enclosure type. Enclosures containing devices that produce excessive heat (resistors) or ozone or devices that require cooling for proper operation may require ventilation. Types 1, 2, 3R, 9 and 12 may be ventilated or nonventilated. Type 1 enclosures are normally specified for indoor cranes. Type 3R enclosures are normally specified for outdoor cranes. Type 12 enclosures are specified for exceptionally dirty environments.

NOTE G:

a. Select industrial motors for MHI CMAA 70, Class A, B, C and D cranes.

b. Select mill motors for MHI CMAA 70 Class E cranes.

c. If industrial motors are specified, select NEMA MG 1.

d. If DC mill motors are specified, select AISE Std. No. 1.

e. Select AC motor (squirrel cage, wound rotor) for the appropriate control system.

f. Select DC series wound motors for DC constant potential control.

g. Select DC shunt wound for DC variable voltage control. Specify hoist motor temperature sensors for hoists subject to low speeds for long periods (greater than 3 minutes) and hoists carrying critical loads; otherwise edit paragraph.

NOTE H:

a. For hoist motors, select Class B insulation with 30-minute rating for MHI CMAA 70 Class A, B, C

cranes with AC or DC magnetic control and a mechanical load brake.

b. For hoist motors, select Class B insulation with a 60-minute rating for MHI CMAA 70 Class A, B, C cranes with AC or DC magnetic control and electrical control braking.

c. For [bridge] [gantry] and trolley motors, select Class B insulation with 30-minute rating for MHI CMAA 70 Class A, B, C cranes with AC or DC magnetic control.

d. For all motors select Class F insulation with a 60-minute rating for MHI CMAA 70 Class A, B, C with AC or DC static controls.

e. For all motors select Class F or H insulation with a 60-minute rating for MHI CMAA 70 Class D and E cranes.

f. For Class F and H insulation include, "permitted by Class B insulation."

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-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-14630 (May 1993)**
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SECTION 14630

OVERHEAD ELECTRIC CRANES
05/93

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NOTE: This guide specification covers the requirements for electric overhead traveling cranes with capacities of 27 metric tons (30 tons) or less, suitable for indoor or outdoor use in hazardous or non-hazardous environments. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

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PART 1 GENERAL

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NOTE: Types covered include (1) top-running bridge and trolley, multiple-girder, with MHI CMAA 70 service class of A through E, (2) top-running bridge, underhung trolley, single girder, with MHI CMAA 74 service class of moderate, and (3) underhung bridge and trolley, single-girder, with MHI CMAA 74 service class of moderate. Control types and systems may be specified as follows:

1. Cab or Pendant Crane Controls or a combination of the two can be provided.

2. Alternating current or dc control systems can be specified.

****

1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 390.03a	(1980; Errata 1983) Gear Handbook Gear Classification, Materials and Measuring Methods for Bevel, Hypoid, Fine Pitch Wormgearing and Racks Only as Unassembled Gears (Partially replaced by AGMA 2000-A)
AGMA 2000-A	(1988; Errata Jan 1989) Gear Classification and Inspection Handbook
AGMA 2001-C	(1995) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
AGMA 6010-E	(1988; Errata Nov 91) Standard for Spur, Helical, Herringbone and Bevel Enclosed Drives
AGMA 6019-E	(1989) Gearmotors Using Spur, Helical, Herringbone, Straight Bevel, or Spiral Bevel Gears

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC ASD Manual	(1989) Manual of Steel Construction Allowable Stress Design

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 159	(1983; R 1993) Automotive Gray Iron Castings
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM A 668/A 668M	(1996) Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM B 438	(1995a) Sintered Bronze Bearings (Oil-Impregnated)
ASTM B 439	(1995) Iron-Base Sintered Bearings (Oil-Impregnated)
ASTM B 612	(1996) Iron Bronze Sintered Bearings (Oil-Impregnated)
ASTM B 633	(1985; R 1994) Electrodeposited Coatings of Zinc on Iron and Steel
ASTM E 125	(1963; R 1993) Magnetic Particle Indications on Ferrous Castings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1	(1989; 90.1b; 90.1c; 90.1d; 90.1e; 90.1g; 90.1i) Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

ASME INTERNATIONAL (ASME)

ASME B30.2	(1996) Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
ASME B30.16	(1993; B30.16a; B30.16b; B30.16c)Overhead Hoist (Underhung)
ASME B30.17	(1992; Errata; Sep 1993; B30.17a; B30.17b; B30.17c; B30.17d) Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)
ASME HST-1M	(1989; R 1995) Electric Chain Hoists
ASME HST-2M	(1989; R 1995) Hand Chain Manually Operated Chain Hoists
ASME HST-3M	(1991, R 1996) Manually Lever Operated Chain Hoists
ASME HST-4M	(1991; R 1996) Performance Standard for Overhead Electric Wire Rope Hoists
ASME HST-5M	(1991; R 1996) Air Chain Hoists
ASME HST-6M	(1986; R 1995) Air Wire Rope Hoists
ASME NOG-1	(1995) Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)

AMERICAN WELDING SOCIETY (AWS)

AWS D14.1	(1985; R 1991) Industrial and Mill Cranes and Other Material Handling Equipment

MATERIAL HANDLING INSTITUTE (MHI)

MHI CMAA 70	(1994) Electric Overhead Traveling Cranes
MHI CMAA 74	(1994) Top Running & Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoist

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(1993) Industrial Control and Systems, Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures
NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 50	(1995; Rev thru Oct 1997) Enclosures for Electrical Equipment
UL 489	(1996; Rev Nov 1997) Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 943	(1993; Rev thru Mar 1997)Ground-Fault Circuit-Interrupters
UL 1449	(1985; Errata Apr 1986; Rev May 1995) Transient Voltage Surge Suppressors

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for

information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Overhead Crane System; [_____].

A complete list of equipment and materials, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions.

Spare Parts; [_____].

Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than [_____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-04 Drawings

Overhead Crane System; GA.

Detail drawings containing complete wiring and schematic diagrams. Diagrams shall indicate each numbered wire, where wire initiates, where wire terminates, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-06 Instructions

Framed Instructions; FIO.

Diagrams, instructions and safety requirements.

SD-09 Reports

Acceptance Testing; [_____].

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. The report shall include the information as required by paragraph ACCEPTANCE TESTING.

SD-18 Records

Hooks; [_____].

Hook material and any heat treatment performed, stamped on the hook shank or documented in certification papers furnished with the hooks. Crane test data recorded on appropriate test record forms suitable for retention for the life of the crane.

SD-19 Operation and Maintenance Manuals

Overhead Crane System; GA.

[Six] [_____] copies of operation and [six] [_____] copies of maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for system startup, operation and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Operation and maintenance manuals shall be approved prior to the field training course.

1.3 QUALIFICATION

Electric overhead cranes shall be designed and manufactured by a company with a minimum of 10 years of specialized experience in designing and manufacturing the type of overhead crane required to meet requirements of the Contract Documents.

1.4 TESTING AND INSPECTIONS

1.4.1 Pre-Delivery Inspections

Contractor shall be responsible for performance of quality control inspections, testing and documentation of steel castings, hook assembly and nuclear safety as follows.

1.4.2 Inspection of Steel Castings

Load-carrying steel castings shall be visually inspected and tested using the magnetic-particle inspection method. Allowable degree of discontinuities shall be referenced to ASTM E 125, and shall be related to service loads and stresses, critical configuration, location and type. Methods of repairing the discontinuities shall be subject to review by the Contracting Officer.

1.4.3 Inspection of Hook Assembly

Hook and nut shall be inspected by a magnetic-particle type inspection or X-rayed prior to delivery. Documentation of hook inspection shall be furnished to Contracting Officer at the field operational testing. As part of the acceptance standard, linear indications will not be allowed. Welding repairs of hook will not be permitted. A hook showing linear indications, damage or deformation will not be accepted, and shall be replaced.

1.4.4 Nuclear Safety Analysis

****

NOTE: Certification is required for cranes handling nuclear materials. Results from the Safety Analysis will be utilized by the Using Agency as a basis for bridge crane certification. Delete this paragraph

if the crane is not required to handle nuclear materials.

****

Nuclear certification, testing, and rules of construction shall be in accordance with ASME NOG-1. Contractor shall submit analysis and test reports to Contracting Officer for approval.

1.5 DESIGN CRITERIA

****

NOTE: The area of hook coverage, runway dimensions, rail size, hook vertical travel, clear hook height and lifting capacity will be clearly shown on drawings.

****

Cranes shall operate in the given spaces and shall match the runway dimensions and rails indicated. Hook coverage, hook vertical travel, clear hook height, lifting capacity, and load test weight shall not be less than that indicated.

1.5.1 General

****

NOTE: Add number of cranes, building name and crane rated load capacity (tonnage). The last sentence may be deleted if only 1 hoist system is in project.

****

The hoisting equipment shall include the following:

Number of cranes; [_____], located in building name; [_____], with a number of tons; [_____], electric overhead traveling crane. The Contractor shall assure that the manufacturer supplying the hoist equipment in Section [_____] is also the manufacturer supplying the hoist equipment in this section.

1.5.2 Classification

****

NOTE: The MHI CMAA 74 specification covers a service classification of moderate industrial service equivalent to MHI CMAA 70 Class C service. Select a moderate service for girder cranes. Refer to NFPA 70 for environmental requirements. Make a selection from the following MHI CMAA 70 service classifications:

1. Class A (Standby or Infrequent Service): This service covers cranes which may be used in installations such as powerhouses, public utilities, turbine rooms, motor rooms and transformer stations where precise handling of equipment at slow speeds with long, idle periods between lifts are required. Capacity loads may be handled for initial

installation of equipment and for infrequent maintenance.

2. Class B (Light Service): This service covers cranes which may be used in repair shops, light assembly operations, service buildings, light warehousing, etc., where service requirements are light and the speed is slow. Loads may vary from no load to occasional full rated loads with 2 to 5 lifts per hour, averaging 3 m (10 feet) per lift.

3. Class C (Moderate Service): This service covers cranes which may be used in machine shops of paper mill machine rooms, etc., where service requirements are moderate. In this type of service the crane will handle loads which average 50 percent of the rated capacity with 5 to 10 lifts per hour, averaging 4.5 m (15 feet), not over 50 percent of the lift at rated capacity.

4. Class D (Heavy-Duty): This service covers cranes which may be used in heavy machine shop, foundries, fabricating plants, steel warehouses, container yards, lumber mills, etc., and standard duty bucket and magnet operations where heavy-duty production is required. In this type of service, loads approaching 50 percent of the rated capacity will be handled constantly during the working period. High speeds are desirable for this type of service with 10 to 20 lifts per hour averaging 4.5 m (15 feet), not over 65 percent of the lifts at rated capacity.

5. Class E (Severe Service): This type of service requires a crane capable of handling loads approaching rated capacity throughout its life. Applications may include magnet, bucket, magnet/bucket combination cranes for scrap yards, cement mills, lumber mills, fertilizer plants, container handling, etc., with 20 or more lifts per hour at or near the rated capacity.

6. Class F (Continuous Severe Service): This type of service requires a crane capable of handling loads approaching rated capacity continuously under severe service conditions throughout its life. Applications may include custom designed specialty cranes essential to performing the critical work tasks affecting the total production facility. These cranes must provide the highest reliability with special attention to ease of maintenance features.
****

Crane shall be designed and constructed to [MHI CMAA 70 Class [_____], [_____] service] [MHI CMAA 74 moderate service] requirements for operation in [hazardous] [non-hazardous] environment with hoist in accordance with [ASME ANSI/ASME HST-1M] [ASME ANSI/ASME HST-2M] [ASME ANSI/ASME HST-3M] [ASME ANSI/ASME HST-4M] [ASME ANSI/ASME HST-5M] [and] [ASME ANSI/ASME HST-6M].

1.5.3 Rated Capacity and Speeds

****

NOTE: Select rated speed under full load for the main hoist, auxiliary hoist (if specified) bridge and trolley from the following: (Speeds are in meters per second (feet per minute)).

1. FLOOR OPERATED INDUSTRIAL CRANES

RATED	HOIST			TROLLEY			BRIDGE		
LOAD	Slow	Medium	Fast	Slow	Medium	Fast	Slow	Medium	Fast
4.5	0.10	0.15	0.25	0.25	0.38	0.51	0.51	0.76	0.89
9	0.08	0.13	0.18	0.25	0.38	0.51	0.52	0.76	0.89
14	0.08	0.10	0.13	0.25	0.38	0.51	0.51	0.76	0.89
18	0.08	0.10	0.13	0.25	0.38	0.51	0.51	0.76	0.89
23	0.05	0.10	0.13	0.25	0.38	0.51	0.38	0.51	0.76
27	0.05	0.08	0.13	0.25	0.38	0.51	0.38	0.51	0.76

1. FLOOR OPERATED INDUSTRIAL CRANES

RATED	HOIST			TROLLEY			BRIDGE		
LOAD	Slow	Medium	Fast	Slow	Medium	Fast	Slow	Medium	Fast
5	20	30	50	50	75	100	100	150	175
10	15	25	35	50	75	100	100	150	175
15	15	20	25	50	75	100	100	150	175
20	15	20	25	50	75	100	100	150	175
25	10	20	25	50	75	100	75	100	150
30	10	15	25	50	75	100	75	100	150

2. CAB OPERATED INDUSTRIAL CRANES

RATED	HOIST			TROLLEY			BRIDGE		
LOAD	Slow	Medium	Fast	Slow	Medium	Fast	Slow	Medium	Fast
9	0.15	0.30	0.46	0.64	0.76	1.02	1.02	1.52	2.03
14	0.15	0.23	0.30	0.64	0.76	1.02	1.02	1.52	2.03
18	0.10	0.15	0.20	0.84	0.76	1.02	1.02	1.52	2.03
23	0.08	0.13	0.15	0.51	0.76	1.02	1.02	1.52	2.03
27	0.08	0.13	0.15	0.51	0.76	1.02	1.02	1.52	1.78

2. CAB OPERATED INDUSTRIAL CRANES

RATED	HOIST			TROLLEY			BRIDGE		
LOAD	Slow	Medium	Fast	Slow	Medium	Fast	Slow	Medium	Fast

2. CAB OPERATED INDUSTRIAL CRANES

RATED	HOIST			TROLLEY			BRIDGE		
LOAD	Slow	Medium	Fast	Slow	Medium	Fast	Slow	Medium	Fast
10	30	60	90	125	150	200	200	300	400
15	30	45	60	125	150	200	200	300	400
20	20	30	40	125	150	200	200	300	400
25	15	25	30	100	150	200	200	300	400
30	15	25	30	100	150	200	200	250	350

3. Auxiliary hoist may be specified for handling light loads (typically 10 to 30 percent of main hoist rated load) at 2 to 4 times the main hoist speed. Micro-drive should be specified if precise handling and position are required. Micro-drive is a single speed drive normally driving the crane at 5 mm/s (1 fpm) or less. Delete reference to micro-drive and auxiliary hoist if not applicable.

****

Rated capacity of crane shall be [_____] tons. Auxiliary hoist capacity shall be [_____] tons. Lower load block or assembly of hook, swivel bearing sheaves, pins and frame suspended by the hoisting ropes shall not be considered part of the rated capacity. Rated speeds (in feet per minute) for the hoist, hoist micro-drive, bridge micro-drive, trolley micro-drive, bridge and trolley at the rated load shall be as follows:

Rated Speeds

Description	Minimum	Maximum	Micro-drive
Main Hoist	[_____]	[_____]	[_____].
Auxiliary Hoist	[_____]	[_____]	[_____].
Trolley	[_____]	[_____]	[_____].
Bridge	[_____]	[_____]	[_____].

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

1.7 FIELD MEASUREMENTS

Before performing any work, Contractor shall become familiar with all details of the work, verify all dimensions in the field, and submit a letter describing the results of this verification including discrepancies to the Contracting Officer and crane manufacture.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

Materials and equipment shall be standard products of manufacturers regularly engaged in the fabrication of complete and totally functional cranes including necessary ancillary equipment.

2.1.2 Nameplates

****
NOTE: Delete identification plates if only one bridge crane is required.
****

Nameplates shall be secured to each major component of equipment with the manufacturer's name, address, type or style, model or catalog number, and serial number. Two bridge identification plates shall be provided, one for each side of bridge. Identified plates shall be noncorrosive metal with letters which are easily read from the floor, showing a separate number such as BC-1, BC-2, for each bridge crane.

2.1.3 Use of Asbestos Products

Materials and products required for designing and manufacturing cranes shall not contain asbestos.

2.1.4 Capacity Plates

Two capacity plates indicating the crane capacity in tons are required, one secured to each side of bridge. Each capacity plate shall be fabricated of a steel backing plate and exterior quality/fade-resistant stick-on labels with letters large enough to be easily read from the floor. Capacity plates shall be placed in a location visible to pendant operator's position after the crane has been installed.

2.1.5 Safety Warnings

Readable warning labels shall be affixed to each lift block or control pendant in a readable position in accordance with ASME B30.16, ASME B30.2 and ASME B30.17. The word "WARNING" or other legend shall be designed to bring the label to the attention of the operator. Warning labels shall be durable type and display the following information concerning safe-operating procedures: Cautionary language against lifting more than the rated load; operating the hoist when the hook is not centered under the hoist; operating hoist with twisted, kinked or damaged rope; operating damaged or malfunctioning hoist; operating a rope hoist with a rope that is not properly seated in its hoist drum groove; lifting people; lifting loads over people; and removing or obscuring the warning label.

2.1.5.1 Directional Arrows

To avoid operation of crane in the wrong direction, the words "FORWARD" and "REVERSE" and accompanying directional arrows shall be affixed in a location on the trolley and bridge which are visible and readable to the operator from pendant station. The words "FORWARD" and "REVERSE" shall agree with the markings on control pendant. Directional arrows shall not be indicated on control pendant.

2.2 STRUCTURAL MATERIALS

2.2.1 Bolts, Nuts and Washers

High-strength bolted connections shall utilize SAE Grade 5 bolts with corresponding lockwashers, nuts, etc., conforming to requirements of AISC ASD Manual bolts. Bolts, nuts and washers shall conform to ASTM A 325 bolts. Galvanized bolts are not acceptable.

2.2.2 Bridge Girders or Girders

****

NOTE: Specify welded structural steel box sections for multiple girder cranes Class C, D, or E with a capacity greater than 18 metric tons (20 tons) or a span greater than 12 m (40 feet).

****

Bridge girders shall be [welded structural steel box sections] [wide flange beams, standard I-Beams, reinforced beams or sections fabricated from rolled plates and shapes].

2.2.3 Bridge Rails or Bars

****

NOTE: Remove this paragraph for underhung cranes and cranes having a capacity less than 18 metric tons (20 tons) (many crane manufacturers do not need or want rails or bars.)

****

Trolley runway rails, crane girders and other sections shall be straight and true. When loaded with motor driven cranes the deflection of rails shall not exceed 1/800 of the span. The deflection shall be calculated with the worst case of two loaded bridge cranes located adjacent each other. Rail joints shall be flush and true without misalignment of running tread and shall be designed to minimize vibration. The gap between adjacent rail ends and the vertical misalignment of running treads shall not exceed 0.0625 inch. The bridge rail shall be leveled to a plus-or-minus 1/8 inch at all rail support joints. Bridge rail shall be fastened to [top cover plate] [wide flange] or centered on flange or offset near web plate for welded box sections, complete with welded clips. Bridge rail joints shall be bolted using standard joint bars. Rail joints shall be staggered. A positive stop shall be provided at bridge rail ends to prevent creep.

2.2.4 End Ties and Bridge Girder End Connections

****

NOTE: Specify end ties for cranes with more than 4 wheels. Specify welded structural steel box sections for multiple-girder cranes Class C, D, or E with a capacity greater than 18 metric tons (20

tons) or a span greater than 12 m (40 feet).
****

Welded steel box sections shall be used for end ties, full depth diaphragms shall be provided at girder connections and jacking points. Horizontal gusset plates shall be provided at the elevation of top and bottom end tie flanges for connection to girder ends. End connections shall be made with high-strength bolts. Body-bound bolts fitted in drilled and reamed holes shall be used to maintain the crane square.

2.2.5 Bridge End Trucks

End trucks shall be the rotating or fixed axle type fabricated of structural tubes or from structural steel to provide a rigid box section structure. Jacking pads shall be provided for removal of wheel assemblies.

2.2.6 Trolley Frame

****
NOTE: Trolley frame is applicable only to multiple girder cranes.
****

Trolley frame shall consist of two structural steel side frames or trucks welded together with one or more structural steel load girts to form a one-piece unit. Pads shall be provided for the use of jacks or wedges when changing truck wheels. All trolley yokes and load bars shall be of drop forged, cast or rolled steel.

2.2.7 Stops and Bumpers

****
NOTE: Rubber bumpers dry out with time. Hydraulic type bumpers are more expensive. Using the words shock-absorbing allows the manufacturer to choose. Rubberlike materials are not acceptable as an option.
****

Crane runways and bridge girders shall be fitted with structural steel end stops. Bridge end trucks and trolley frames shall be fitted with shock-absorbing, [spring] [or] [hydraulic] type bumpers capable of decelerating and stopping the bridge and/or trolley within the limits stated by OSHA and MHI CMAA. Trolley end stops shall be of sufficient strength to withstand the impact of a fully loaded trolley moving at 50 percent of maximum rated travel speed. When two bridge cranes are on the same runway, one crane shall be fitted with shock-absorbing bumpers on each end of each end-truck, and the other crane shall have shock-absorbing bumpers as per above on one end only of each end-truck which is the opposite end of the adjacent crane. The other end of the end-truck shall be fitted with a structural steel stop to engage the bumpers of the adjacent crane. Bridge bumper stops shall be provided as specified in Section 05120 STRUCTURAL STEEL.

2.2.8 Footwalks

****
NOTE: Delete the following paragraph if double-girder cranes are not required. Footwalk

fall protection shall be provided with guard rails or static line with safety belts.

****

A full-length structural platform is required on the driver's side of the bridge. The platform shall be checkered steel flooring, double member handrail and a suitable toe-guard, with 30 inch clearance in front of control equipment. Minimum 15 inch clearance is required in front of bridge machinery. Short and full rear platforms and cross-over walks are optional.

2.2.9 Runway Rails

The runway rail size shall be as recommended by crane manufacturer.

2.2.10 Operator's Cab

****

NOTE: Applicable if a cab is specified, otherwise delete paragraph. Specify enclosed cab for outdoor use. Open cab may be used indoors. Enclosed cabs can be provided with a heating and/or air conditioning unit according to environmental conditions. Specify the location of cab and the direction the operator should face.

****

2.2.10.1 Design

Operator's cab shall be designed and constructed in accordance with [MHI CMAA 70][MHI CMAA 74] and ASME B30.2. Location of cab access shall be easily accessed by crane operator. Cab shall have space near cab entrance for storage of a carbon-dioxide, dry chemical, or equivalent hand fire extinguisher.

2.2.10.2 Cab Construction

Cab shall be [fixed cab mounted on bridge] [trolley mounted cab] of the [enclosed] [open] type for [outdoor] [indoor] use, and designed to provide a clear view of the operating floor and hook for operator. Cab shall be provided with a suitable [heating] [heating and air conditioning] unit. Cab shall be located on the [_____] of the [bridge] [trolley] with the operator facing [_____].

2.2.11 Additional Provisions for Outside Service

Welded structural members on outdoor cranes shall be seal welded. Crane bridges shall be provided with parking brakes which will sufficiently hold the crane against a wind pressure of 5 psf for in-service conditions. Crane bridges shall be provided with manually-operated pin locks at each rail, designed to securely anchor the crane against a wind pressure of 30 psf for out-of-service conditions.

2.3 MECHANICAL EQUIPMENT

2.3.1 Drives

2.3.1.1 Bridge Drives

****

NOTE: If the span is less than 12 m (40 feet) and the application is MHI CMAA Class "A" or "B", then A-1 drive may be included as an option.

****

Bridge drives shall be [either the A-1 or] [A-4] drive arrangement as specified in MHI CMAA 70 or MHI CMAA 74. Bridge drive shall consist of a single electric motor mechanically connected through gear reduction and drive shafts to the drive wheels or separate drive motors at each end of bridge. Acceleration and deceleration shall meet the requirements specified in this section. Gears shall conform to applicable AGMA standards. Gear reducers shall be oil tight and fully enclosed with pressure or splash type lubrication. Bridge-travel limit-switches are optional.

2.3.1.2 Trolley Drives

Trolley shall be complete with a drive arrangement with a minimum of two wheels driven by an integral electric motor. Drive mechanism shall run in totally enclosed oil bath. Limit switches are optional for drive mechanism. Acceleration and deceleration controls shall meet requirements specified in this section.

2.3.1.3 Micro-Drives

****

NOTE: Include those motions where a micro-drive is required. If micro-drive is not specified, delete these paragraphs. Micro-drives are generally required when slow speeds are required for an extended amount of time. If precision movement is required for limited time for final positioning of loads, use adjustable frequency or dc variable voltage crane controls instead of micro-drives.

****

The following crane motions shall be provided with a separate micro-drive: [main hoist], [auxiliary hoist], [trolley drive] [and] [bridge drive]. The micro-drives shall be used to precisely position loads. Each micro-drive shall consist of an electric motor, gear reducer, magnetic coupling clutch and necessary controls. The output shaft of the reducer shall be connected to an extension of the primary drive high-speed shafting with a magnetic coupling clutch. Coupling shall normally be disengaged and shall be engaged only if the micro-drive is required. Electrical clutch components required for proper operation shall conform to the requirements specified in paragraph ELECTRICAL COMPONENTS. Clutches shall be the magnetic coupling type, and shall engage and disengage the micro-drives from the high speed shafts of the main drive arrangement. The clutch shall be engaged by electromagnet and released by springs. Clutch ratings shall be not less than 150 percent of the micro-motor rated torque as amplified by the intervening gearing. Clutch enclosures shall facilitate easy access for wear inspection of the friction elements and visual examination of the clutch assemblies.

2.3.2 Load Blocks

2.3.2.1 Main and Auxiliary Hoist Load Blocks

Load blocks shall be of welded steel construction. Load blocks shall be provided with hot-rolled or forged steel fixed crosshead separate from the sheave pin with swivel mounting for forged steel hook. Each lubrication fitting for sheave pins shall be an independent type recessed within the sheave pin or adequately guarded to prevent damage. The pitch diameter of the sheaves shall be not less than 16 times the rope diameter. Sheaves shall be supported by roller type bearings on steel sheave pins. Provisions for external lubrication shall be provided to allow pressure relief and purging of old grease. Sheave blocks shall be constructed to provide maximum personnel safety and to prevent the hoist rope from leaving the sheaves under normal operating condition.

2.3.2.2 Hook Assembly

****

NOTE: If specific hook dimensions are provided in the drawings, include the appropriate sentence; otherwise manufacturer's standard hook will be provided. If hooks are required to be disassembled and inspected, include appropriate sentence.

****

Hooks shall be single barbed and shall be made of forged steel complying with ASTM A 668/A 668M Hook dimensions shall be as shown. Hooks shall be fitted with safety latches designed to preclude inadvertent displacement of slings from the hook saddle. Painting or welding shall not be performed on the hook. Hook nut shall be secured with a removable type set screw or other similar fastener, but shall not be welded. Hooks shall be designed and commercially rated with safety factors in accordance with MHI CMAA. The hook shall be free to rotate through 360 degrees when supporting the rated load.

2.3.3 Hoisting Ropes

Hoisting ropes shall be regular lay, preformed, uncoated, improved plow steel, 6 by 37 construction, with independent wire rope core. Ropes shall be suited to meet the service requirements. Rope socketing or U-bolt clip connections shall be made in accordance with clip or rope manufacturer's recommendation, and shall be equal to or greater than the rope strength. Hoisting ropes shall be the rated capacity load plus the load block weight divided by the number of rope parts, and shall not exceed 20 percent of the certified breaking strength of rope. Hoisting ropes shall be secured to hoist drum so that no less than two wraps of rope remain at each anchorage of hoist drum at the extreme low position (limit switch stop).

2.3.4 Sheaves

****

NOTE: Sheaves are used in the reaving similar to pulleys and are not required on single reaved hoist.

****

Sheaves shall be of cast, forged, rolled, or welded structural steel. Sheave grooves shall be accurately machined, smoothly finished and free of surface defects.

2.3.5 Hoist Drums

Hoist drums shall be of welded rolled structural steel, cast steel, or seamless steel pipe. Drums shall be machined and provided with right-hand and left-hand grooves to take the full run of cable for the required lift without overlapping, plus a minimum of two full wraps of cable when load is on floor. At least one groove shall remain unused when hook is at the highest position. Drum grooves shall be cut from solid stock and have sufficient depth for size of cable required. Drum flanges shall be guarded so that the cable cannot wedge between drum flange and hoist frame.

2.3.6 Gearing

Gearing shall be of the enclosed gear reducers type. Gears and pinions shall be spur, helical, or herringbone type only, and shall be forged, cast or rolled steel; open-type gearing is not acceptable. Gears and pinions shall have adequate strength and durability for the crane service class and shall be manufactured to AGMA 2001-C Quality Class 6 or better precision per [AGMA 390.03a][AGMA 2000-A].

2.3.6.1 Gear Reducers

Gear reducers shall be standard items of manufacturers regularly engaged in the design and manufacture of gear reducers for Class D and G cranes or shall be integral components of standard hoists or hoist/trolley units of manufacturers regularly engaged in the design and manufacture of hoists or hoist/trolley units for Class A, B or C cranes. Gear reducers shall be designed, manufactured and rated in accordance with AGMA 6010-E, AGMA 6019-E (for trolley drives only), as applicable. Except for final reduction, the gear reduction units shall be fully enclosed in oil-tight housing. Gearing shall be designed to AGMA standards and shall operate in an oil bath. Operation shall be smooth and quiet.

2.3.7 Brakes

Brakes shall be of the shoe, disc, or conical type with thermal capacity suitable for class and service specified in this section. Shoe, disc, and conical brakes shall be spring-set and electrically-released by a continuously rated direct acting magnet. Brakes shall be self-aligning and provide for easy adjustment for torque setting and lining wear. Brake lining material shall be asbestos free. Brake wheels shall be cast iron conforming to ASTM A 159 or shall be the manufacturer's standard high-strength ductile cast-iron, provided that the material exhibits wear characteristics in the form of powdered wear particles and is resistant to heat-checking. Disc brakes shall be totally enclosed and have multiple discs with stationary releasing magnets. Brake torque shall be easily adjustable over a 2:1 torque range.

2.3.7.1 Hoist Holding Brakes

****

NOTE: If non-critical loads are handled, one hoist holding brake should be specified. If critical loads are handled, two holding brakes should be specified.

****

Each hoist shall be equipped with at least [1] [2] holding brakes. Holding brake shall be disc, shoe, or conical design, applied to one of the following: motor shaft or gear reducer shaft or rope drum. Braking system shall be designed to have zero hook lowering motion when a raise motion is initiated. Primary brake shall be a spring-set, electrically-released, disc, shoe, or conical type brake. Brake shall have a minimum torque rating of 150 percent of motor torque. Brake shall be capable of holding the rated load with zero hook drift. Primary brake shall be automatically set when controls are released or when power is interrupted. Provisions shall be made to facilitate easy brake adjustment. Hoists shall be furnished with mechanical-control braking or a power-control braking system. Typical power means include dynamic lowering, eddy-current braking, counter-torque, regenerative braking, variable frequency, and adjustable or variable voltage.

2.3.7.2   Hoist Control Brake

****

NOTE: Mechanical load brake shall be allowed only in MHI CMAA Class "A", "B" or "C" applications with less than 6 m (20 foot) maximum lift height. Electrically controlled system breaking will be used in MHI CMAA Class "D" and "E" applications.

****

[Each hoist shall be equipped with an integral mechanical load brake of the "Weston" type or multiple-disc type. Multiple disc-type brake shall be provided with external adjustment for wear.] [Each hoist shall be provided with electrically-controlled braking system to prevent overspeeding.]

2.3.7.3   Trolley Brake

****

NOTE: 1. Coordinate selection of motor type with selection of control type.

2. Select applicable ac or dc control system.

3. Include micro-drive motors if micro-drive motors are specified; otherwise delete.

4. If micro-drive is specified include clutches; otherwise delete.

5. If dc control system specified, include sentence concerning control rectifiers.

6. Include thyristors if dc variable specified; otherwise delete.

7. Delete requirement for rectifier bridge if ac control systems are used.

8. Select protective enclosure type. Enclosures containing devices that produce excessive heat (resistors) or ozone or devices that require cooling for proper operation may require ventilation. Types 1, 2 and 3R may be ventilated or non-ventilated.

Type 12 enclosures are non-ventilated, but may include sections and compartments that are ventilated. Type 1 enclosures are normally specified for indoor cranes. Type 3R enclosures are normally specified for outdoor cranes. Type 12 enclosures are specified for exceptionally dirty environments.
****

[Trolley braking system shall be provided with spring-applied and electrically-released shoe, disc, or conical brakes.] [Trolley braking system shall be provided with electrically-operated and hydraulically-operated shoe, disc, or conical brakes. Hydraulic portion of braking system shall be designed so that the shoes will become disengaged by spring pressure and set by hydraulic pressure. Electrical portion of the braking system shall be designed such that the shoes will be spring-applied and electrically-released.] Braking system shall be automatically set when controls are released or power is interrupted. Provisions shall be made to facilitate easy brake adjustment. Brakes shall have a torque rating of at least 50 percent of trolley drive motor rated torque.

2.3.7.4 Bridge Brakes

[Bridge braking system shall be provided with a spring-applied and electrically-released single shoe, disc, or conical brake for each bridge drive motor.] [Bridge braking system shall be provided with electrically-operated and hydraulically-operated shoe, disc, or conical brakes. Hydraulic portion of braking system shall be designed so that the shoes will be disengaged with spring pressure and set with hydraulic pressure. Electrical portion of braking system shall be designed so that the shoes will be spring-applied and electrically-released.] Braking system shall be automatically set when controls are released or power is interrupted. Provisions shall be made to facilitate easy brake adjustment. Brakes shall have a torque rating of at least 50 percent of bridge drive motor rated torque.

2.3.8 Wheels

****
NOTE: Include the second sentence for MHI CMAA 70 class D and E, cranes; otherwise delete. Include the requirement for trolley wheels only for multiple girder cranes.
****

Wheels shall be manufactured of rolled or forged steel. Wheel treads and flanges shall be rim toughened to between 320 and 370 Brinell hardness number. [Bridge] [Bridge and trolley] wheels shall be double-flanged. Trolley wheels shall have straight treads. Bridge wheels shall have straight treads. Wheels shall be equipped with self-aligning double-row spherical roller-bearings of capacity as recommended by bearing manufacturer for design load of trolley or bridge.

2.3.9 Bearings

****

NOTE: Equalizer sheaves compensate for unequal length, stretch of the hoisting, and swinging of the load block.
****

Bearings shall be antifriction type, except bearings which are subject only to small rocker motion. Equalizer sheaves shall be equipped with sintered oil-impregnated type bushings in accordance with ASTM B 438, ASTM B 439, or ASTM B 612.

2.3.10 Anti-Drip Provisions

****
NOTE: Delete this paragraph if lubricant leaks are acceptable on the operating floor.
****

Cranes shall be designed to preclude leakage of lubricants onto the lifted loads or the floor. Equipment and components which cannot be made leak-proof shall be fitted with suitable drip pans. Drip pans shall be manufactured of steel and designed to permit removal of collected lubricant.

2.3.11 Lubrication System

Splash-type oil lubrication system shall be provided for hoist, trolley and bridge gear cases; an oil pump shall be used on vertical-mounted gear cases exceeding two reductions. Oil pumps shall be the reversible type capable of maintaining the same oil flow direction and volume while being driven in either direction. Electric motor-driven pumps may be used when input shaft speed is too low at any operating condition to ensure adequate oil flow. In such applications, pump shall be energized whenever drive mechanism brakes are released.

2.4 ELECTRICAL COMPONENTS

2.4.1 Explosion Proof Requirements

****
NOTE: Delete this paragraph if explosion proofing is not part of design criteria. Define hazardous classification and evaluate Contractor's proposal for electrical equipment. Show location of the hazardous areas.
****

Equipment and wiring in locations indicated shall conform to NFPA 70 for Class [I] [II] [III], Division [1] [2] hazardous locations. Equipment shall be suitable for [Group [_____]] [operating temperature of [_____] degrees F]. Wiring and equipment in locations indicated shall be of the classes, groups, divisions, and suitable for the operating temperature as indicated.

2.4.2 Control Systems

2.4.2.1 Hoist Control System

****
NOTE: Select the appropriate paragraph for system

desired. Delete auxiliary hoist when not required.

Selection of the desired control system must be coordinated with the appropriate motor selection. Different control systems may be selected for hoists and travel in order to obtain the desired control characteristics. The following are options for the various control/motor combinations:

1. Alternating current Magnetic Control, ac Squirrel Cage Motors: Squirrel cage motors have only limited usefulness on cranes. Application is limited to light-duty weight handling service requiring not more than about 15 kW (20 HP) motors. These motors are used where hook or travel speed is slow, operation is by unskilled personnel, and elaborate speed control and accurate positioning of the load is not required. The main advantage of selection of this control and motor arrangement is low cost and simple maintenance for light capacity cranes.

2. Alternating Current Magnetic Control, ac Wound Rotor Type Motors: ac wound rotor type motors with ac magnetic controls are well suited for high capacity weight handling service (heavy duty crane with large motors). Alternating current magnetic control with ac wound rotor motors is generally used when there is a restricted range of speed and load, and there are no requirements for precision handling.

3. Alternating current Stepless Secondary Saturable Reactor Control, ac Wound Rotor Type Motors: Control of the system is essentially stepless and fine control is provided. Speed is determined by the master switch setting independent of the load weight. Static stepless control is not suited for extended low speed operation. Static control is suitable for all crane services and is normally specified when good regulated speed control is required.

4. Alternating current Adjustable Frequency Control, ac Squirrel Cage Motors: ac adjustable frequency control uses ac squirrel cage motors and a sine-coded pulse width modulated voltage to develop a sinusoidal current waveform from a rectified filtered ac power source. This type of control system will provide stepless speed control with smooth acceleration and deceleration, precise regulated speed control, and fine minimum speed capability.

5. Direct current Magnetic Control, dc Series Wound

Motors: dc series wound motors with dc magnetic control are usually used in existing applications where dc mainlines are present.

6. Direct current Variable Voltage Control, dc Shunt Wound Motors: dc variable voltage control uses dc shunt wound motors and a static conversion unit to convert ac power to dc for the motor. This type of control system will provide stepless speed control with smooth acceleration and deceleration, precise regulated speed control, and fine minimum speed capability.

7. Alternating current Magnetic Hoist Control Selection:

a. An ac wound rotor motor with ac magnetic control, reversing, with mechanical load brake. This type of control is the least expensive control. Good positioning and landing speeds are inherently available for only a fraction of the loads, and jogging must be heavily relied on. This type of control should be used only for rough (nonprecision) handling situations.

b. An ac wound rotor motor with ac magnetic control, reversing, with automatically controlled eddy-current brake. The eddy-current brake provides a load on the motor permitting unregulated speed control. This control is suitable for applications that do not require accurate positioning of loads, and where there are no requirements for precision handling.

c. An ac wound rotor motor with ac magnetic control, reversing, countertorque control braking means. This control system is commonly used for bracket and magnet handling cranes. The control is only suited to those applications where at least 50 percent rated load is on the ropes at all times. If the hoist is operated in lower mode without a substantial load, the load may actually go up.

8. Alternating current Magnetic Travel Control Selection: An ac wound rotor motor with ac magnetic control, 5 speed, reversing, plugging type. This type of control provides rough acceleration under rated load. The bridge or trolley will accelerate almost to full speed regardless of control point selected.
****

Main hoist and auxiliary hoist motion control system shall be [[single] [two] speed, with ac magnetic control of ac squirrel cage motor] [[single] [two] speed, with ac magnetic control of ac wound rotor motor]. Control shall provide for reversing, and for [a mechanical load brake] [an automatically controlled eddy-current brake] [a countertorque control brake] [ac stepless secondary saturable reactor control of an ac wound rotor type motor] [ac adjustable frequency control of an ac squirrel cage motor] [dc magnetic control of a dc series wound motor] [dc variable voltage control of a dc shunt wound motor].

2.4.2.2 Travel Control System

Bridge and trolley motion control system shall be [[single] [two] speed with ac magnetic control of squirrel cage motors] [five-speed with dc magnetic control of ac wound rotor motors] [ac static stepless secondary saturable reactor control] [ac adjustable frequency control] [five-speed dc magnetic constant potential control].

2.4.2.3 Drive Control System

****

NOTE: Select dc micro-drive control for ac mainline power control systems and dc micro-drive control for dc mainline power control systems.

****

The [main hoist], [trolley] [and bridge] micro-drive control systems shall be [ac] [dc] magnetic, single speed, reversing.

2.4.3 Power Sources

2.4.3.1 System Supply Voltage

Cranes shall be designed to be operated from a [_____] volt, [three-phase, 60 Hz, alternating current] [direct current] system power source. Energy isolating devices for such machine or equipment shall be designed to accept a lockout device in accordance with NFPA 70.

2.4.3.2 Transformers

****

NOTE: This paragraph is applicable to ac power supplies only.

****

Transformers shall be dry type suitable for the application.

2.4.3.3 Power Rectifiers

****

NOTE: Applicable rectifier requirements must be coordinated for each specific job. Select totally enclosed non-ventilated enclosure for indoor and outdoor usage. Select totally enclosed fan cooled enclosure for motors operating at rated speed for long periods. Select forced ventilated air over frame enclosure for motors operating at slow speed for long periods or for severe-duty cycle service.

****

Power rectifiers shall be provided where required to convert ac to dc. active semiconductor devices shall be silicon type. Rectifiers for motor control system shall be three-phase full wave rectifiers. Rectifiers for brakes shall be single-phase full-wave or three-phase full-wave rectifiers. A single rectifier may be used in lieu of several smaller rectifiers; brakes shall be supplied from a different rectifier than the other equipment. Protective enclosures shall conform to the requirements of NEMA ICS 6 Type [_____]. Rectifying elements shall be hermetically-sealed and mounted on heat sinks cooled by natural convection or by mechanical means. Minimum protection for rectifiers shall consist of transient surge suppressors, and 100,000 AIC current-limiting 700V rectifier type fuses in the ac line. Minimum protection for main power rectifiers shall include a line isolation transformer of the type specifically designed for use with static conversion units. Individual diode sets and thyristors shall be protected by fuses on the ac side. Each rectifier bridge used in brake circuits (including overload protection) shall be rated for continuous-duty at a minimum of 150 percent of load rating, and for 1 minute at a minimum of 300 percent of load rating. Each rectifier or SCR bridge used in the [dc constant potential control system] [or in] [dc variable voltage] shall be rated for continuous-duty at a minimum of 100 percent of the load rating, and for one minute at a minimum of 200 percent of load rating following 8 hours at 100 percent load. The dc rated output voltage shall not exceed 460 volts.

2.4.4 Motors

****

NOTE: Specify hoist motor temperature sensors for hoists subject to low speeds for long periods (greater than 3 minutes) and hoists carrying critical loads; edit paragraphs as required. Motor heaters are desirable for outdoor cranes, unheated warehouse service cranes, or any other condensing high-humidity application. Select a motor from the following types and coordinate with the desired control type.

a. For critical load handling, self-excited alternator with electrical load brakes or emergency dynamic braking is preferred.

b. Select crane type motors for ac motors.

c. Select 800 Series dc mill type motors or dc industrial motors for dc motors.

d. If crane and/or industrial type motors are specified, select NEMA MG 1.

e. If 800 Series dc mill type motors are specified, select AISE Std No. 1.

f. Select dc motor type (squirrel cage, wound rotor) for the appropriate control system.

g. Select dc series wound motors for dc constant potential control.

h. Select dc shunt wound for dc variable voltage control.

****

2.4.4.1 General Requirements

Motors shall be designed specifically for crane and hoist duty. Drain holes shall be provided at low points near each end. Inspection and service covers shall be provided with gaskets. Hardware shall be corrosion-resistant. Motors shall conform to the requirements of NEMA MG 1. Motor heaters shall be energized when mainline contactor is de-energized, and water heaters shall be de-energized when mainline contactor is de-energized. Motors 20 HP and larger shall be provided with a suitable heater to prevent condensation during long periods of inactivity. One thermal sensitive device embedded in hoist motor windings shall be provided. Device and associated circuitry shall serve as an alarm activating an amber signal or pilot light visible to control stations when motor temperatures become excessive. Set point shall be set below the Class B insulation temperature limit. Thermal-sensitive device and associated circuits shall be self-restoring (automatic reset). Two-speed, two-winding motors with a solid-state control will not be allowed for creep-speed use.

2.4.4.2 Main and Auxiliary Hoist Motor

Hoist motor shall be [dc crane type] [dc industrial type] [800 Series dc mill type] [[single-speed; single-winding] [two-speed; two-winding]] [NEMA design D squirrel cage ac type] [wound-rotor type ac type] [ac squirrel cage type for use in ac adjustable frequency control systems] [dc series wound type] [dc shunt-wound type].

2.4.4.3 Bridge and Trolley Drive Motors

Bridge and trolley drive motors shall be [ac crane type] [dc industrial type] [800 Series dc mill type] [[single-speed; single-winding] [two-speed; two-winding]] [NEMA design B squirrel cage ac type rated] [wound rotor ac induction type] [ac type designed for ac adjustable frequency operation] [dc series wound type] [dc shunt-wound type].

2.4.4.4 Motor Enclosures

****

NOTE: Applicable to 1 or 2 speed ac magnetic control of ac squirrel cage motor. If it is not desirable to have the motor immediately reverse direction, include sentence on plugging to allow the motor to stop prior to reversing direction. If excessive load swing cannot be tolerated during the start of the bridge or trolley, include sentence on reduced voltage starting.

****

Motor enclosures shall be [totally enclosed, non-ventilated (TENV)] [totally enclosed, fan cooled (TEFC)] [totally enclosed, air-even frame (TEAD)]

2.4.4.5 Hoist Motor Insulation and Time Rating

****
NOTE: For hoist motors, select Class F insulation with 30 minute rating based on a rated temperature rise of 85 degrees C by resistance above a 40 degree C ambient for MHI CMAA 70 Class A, B, C cranes and MHI CMAA 74 cranes with ac or dc magnetic control and a mechanical load brake.

For hoist motors, select Class F or H insulation with a 60 minute rating based on a rated temperature rise of 85 degrees C by resistance above a 40 degree C ambient for MHI CMAA 70 Class A, B, C cranes and MHI CMAA 74 cranes with ac or dc magnetic control and electrical control braking.

For bridge and trolley motors, select Class F insulation with 30 minute rating for MHI CMAA 70 Class A, B, C cranes and MHI CMAA 74 cranes with ac or dc magnetic control.

For all motors, select Class F or H insulation with a 60 minute rating based on a rated temperature rise of 85 degrees C by resistance above a 40 degree C ambient for MHI CMAA 70 Class A, B, C and MHI CMAA 74 cranes with ac or dc static controls.

For all motors, select Class F or H insulation with either a 60 minute, 120 minute or 120 minute with frame size selection based on continuous rating, based on a rated temperature rise of 85 degrees C by resistance above a 40 degree C ambient for MHI CMAA 70 Class D and E cranes.

Delete frame size selection if not needed for the project.
****

Hoist motors shall be provided with insulation which has a [Class B/30] [Class F/60] [Class H/120] minute minimum motor time rating based on an 80 degree C motor temperature rise above 40 degrees C ambient, with frame size selection based on continuous ratings.

2.4.4.6 Bridge and Trolley Motor Insulation and Time Rating

Bridge and trolley drive motors shall be provided with an insulation which has a [Class B/90] [Class F/60] [Class H/120] minute minimum motor time rating based on 85 degrees C motor temperature rise above 40 degree C ambient with frame size selection based on continuous rating.

2.4.4.7 Micro-Motors

Micro-motors for [main hoist] [auxiliary hoist] [bridge] [and trolley] drives shall be [direct current industrial type, shunt wound motors] [industrial type, single-speed; single-winding; ac squirrel cage motor] operation and shall conform to the requirements of NEMA MG 1. Micro-motor shall be totally enclosed, fan cooled (TEFC), with Class F or H insulation. Motor voltage rating shall comply with system supply voltage rating specified.

2.4.5 Electric Brakes

2.4.5.1 Brakes

****

NOTE: Delete this paragraph if hydraulic braking system is not required.

If electric brakes are used, a drift point may be provided so the brakes will release after the motor is de-energized, thereby allowing the motion to coast and reducing swing of the load. A drift point can also allow the trolley to center itself over the load before actually starting to lift.

****

Electric-hydraulic [bridge] [trolley] brakes shall be dc shunt magnet type equipped with hydraulic actuators manually-operated with a foot-operated master control unit in the operator's cab, and electrically released with the operation of the mainline contactor POWER-OFF pushbutton or power failure. Remote control bleeders operable by pushbutton and foot pedal shall be provided except for power-assisted brake systems. Remote control bleeders shall be complete with pushbutton clearly labeled and located in operator's cab where the operator can easily depress the pushbutton and pump the brake simultaneously. In lieu of the combination electric-hydraulic brakes, separate hydraulic and electric brakes may be provided. Hydraulic brake system shall be designed to ensure equal pressure at each brake cylinder.

2.4.5.2 Hoist Brake Time Delay

****

NOTE: Delete this paragraph if one brake is specified.

****

One of the hoist holding brakes shall be provided with a time-delay setting (from 1 to 3 seconds). The time-delay shall be initiated upon releasing the control pushbutton or returning the master switch to OFF. Operation of mainline POWER-OFF pushbutton or power failure shall result in each hoist brake's setting without any time-delay.

2.4.5.3 Automatic Stop System

Electrically-controlled brakes shall be fail-safe spring set when power is interrupted. Brakes shall be released with a mainline contactor POWER-OFF pushbutton or a master switch for the associated drive. Brakes shall automatically stop when there is a power failure. Electric shall be designed to be mechanically released. Enclosures for electrical-controlled brake components shall be NEMA ICS 6 Type [_____]. Direct current shunt magnetic shoe brakes shall be provided with an electrical forcing circuit for rapid release of brake. Each shunt coil brake shall be circuited for both conductors to open simultaneously when the brake is de-energized.

2.4.6   Control System

A separate controller shall be provided for each motor; a duplex type for 2-motor bridge drives and a quadraplex type for 4-motor bridge drives on ac central cranes. When 2-motor bridge drives are furnished and dc magnetic control is required, dc series-connected motors shall be provided. When 4-motor bridge drives are furnished and dc magnetic control is required, dc series-parallel connected motors shall be provided. Overload protection shall be in conformance with requirements of NEMA ICS 2 and NFPA 70. When contactors are used for starting, stopping and reversing, contactors shall be mechanically and electrically interlocked.

2.4.6.1   Control Panels

****

NOTE: Control panel heaters are desirable for outdoor cranes, unheated warehouse service cranes or any other condensing high-humidity application. Alternating current or dc static crane control for outdoor cranes need thermostatically-controlled panel heaters for outdoor panels or any other application which is colder than 0 degrees C. Alternating current or dc static crane control may need both thermostatic control and mainline contactor control.

****

Control panels shall be fabricated of solid sheet steel designed and constructed to conform to requirements of NEMA ICS 6 Type [_____]. [Thermostatically-controlled heaters to keep control enclosure temperatures at or above 0 degrees C shall be provided in each static crane control panel.] [Control panel heaters shall be energized when mainline contactor is de-energized, and shall be de-energized when mainline contactor is energized to prevent anti-condensation.] Control panel doors shall be hinged, equipped with gaskets and fitted with key-lock handle design, complete with a single key to open all locks.

2.4.6.2   Main and Auxiliary Hoist Control

****

NOTE: Select a hoist control from the following paragraphs a through i and coordinate with paragraph Motors.

****

a. Hoist motor control system shall provide one speed in each direction with an electrically-operated, full-magnetic, across-the-line reversing type starter. Speed contactors shall be used to prevent the operation of high speeds and low speeds.

b. Hoist motor control system shall provide two speeds in each direction with of an electrically-operated, full-magnetic, across-the-line reversing type starter. Electrical and mechanical interlocks shall be used to prevent the operation of high speeds and low speeds.

c. Hoist motor control shall provide five-speed dc magnetic control of ac wound rotor motor with eddy-current braking. Eddy-current brake shall provide an adjustable varying artificial loading of wound rotor hoist motor on at least two hoisting points and four lowering points. Operation of hoist shall be prevented upon loss of eddy-current brake excitation. Eddy-current brake shall be excited with reduced voltage when hoist control is in the OFF position. Positive-drive down is required on all lowering points. On first speed-point hoisting, hook shall not lower with 100 percent of rated load, and the no-load hook speed shall not exceed 30 percent of rated speed. On first speed-point lowering, the full-load hook speed shall not exceed 15 percent of synchronous motor speed. A self-excited alternator shall be mounted on the electric load brake housing to excite load brake if power supply and holding brakes fail.

d. Hoist motor control shall provide five-speed dc magnetic control of ac wound rotor motor with a mechanical load brake. First point for hoisting shall provide not more than 40 percent of full-load motor torque. First point lowering speed with any load up to rated load shall not exceed more than 80 percent of full-load hoisting speed. Second point lowering shall cause 75 percent of rated load to lower at not more than 50 percent of full-load hoisting speed.

e. Hoist motor control shall provide five-speed, countertorque control for wound rotor motors. When the control handle is in the fourth and fifth point lowering position there shall be a positive drive down of the hook or load to not less than synchronous speed nor more than 25 percent of synchronous speed with full-rated load. This fourth and fifth point for lowering shall provide regenerative braking. All other lowering points shall provide speed retardation by the application of countertorque. Countertorque shall increase as the control handle is moved toward the NEUTRAL or OFF position. Countertorque secondary-resistance control shall provide for not less than five manually held and one automatic speed point in each direction of motion.

f. Hoist motor control shall provide ac static stepless secondary saturable reactor control. Control shall provide continuously-adjustable speeds throughout the range from minimum speed to maximum speed. Eddy-current braking shall provide a retarding torque for control of light loads in the hoisting direction and all loads in the lower direction of subsynchronous speed. To reduce holding brake wear, control shall be arranged so that the electric load brake is effective in slowing the motion when the control is in OFF position. Minimum hoist position of control shall not allow hook to lower with full-rated load on the hook. Minimum lowering speed at rated hook-load shall not exceed 15 percent of synchronous motor speed. Minimum speed hoisting with an empty hook shall not exceed 20 percent of synchronous motor speed. Loads up to 100 percent rated capacity shall raise on minimum speed point of master. A self-excited alternator shall be mounted on electric load brake housing to excite the load brake, if power supply and holding brakes were to fail.

g. Hoist control system shall provide reversing, constant potential dc, five-speed, dynamic lowering, variable-resistance, dc magnetic control of dc series wound hoist drive motors. Full-load lowering speed shall not exceed the following percentages of rated full-load hoisting speeds: 30 percent on first point; 205 percent on fifth speed point. First point hoisting shall provide not more than 30 percent of rated-motor speed at no-load motor torque, and zero speed (plus 5 percent, minus 0 percent of rated speed) at not less than 60 percent of rated-motor torque. Emergency dynamic speed at no-load motor torque. Emergency dynamic braking circuits shall be established when the motion control switch is in the OFF position and when power supply is disrupted.

h. [Hoist motor speed control shall provide dc stepless, speed regulated, adjustable-voltage control of dc shunt-wound motors. Control shall provide continuously adjustable speed from minimum speed to full speed. Minimum hoist position of control shall not allow hook to lower with 125 percent of full-rated design load on hook, and the minimum lower position of control shall provide a full-rated design-load lowering speed at not more than 2 percent of rated speed. Control shall provide automatic regenerative or dynamic braking for speed reduction and slow down before brake setting.] [Emergency dynamic braking shall be provided when control is in the OFF position and in case of power failure.] [Control shall provide a 50-to-1 speed range.]

i. [Hoist motor speed control shall provide ac adjustable frequency-regulated, control of ac squirrel cage motors. Control speed shall provide continuously-adjustable speed from minimum speed to full speed. Minimum hoist position of the control shall not allow hook to lower with 100 percent of full-rated design load on hook, and the minimum lower position of control shall provide a full-rated design-load lowering speed at not more than 3.3 percent of rated speed. Control shall provide automatic regenerative or dynamic braking for speed reduction and slow down before brake setting.] [Emergency dynamic braking shall be provided when control is in the OFF position and in case of power failure, or a self-excited alternator shall be mounted on the electric load brake housing to excite the load brake if power supply and holding brakes fail.] [Control shall provide a minimum 30-to-1 speed range.]

2.4.6.3   Bridge and Trolley Control

****

NOTE: Select a bridge and trolley control from following paragraph a through f and coordinate with paragraph Motor Enclosures.

****

a. [Bridge and trolley main control systems shall provide [one] [two] speeds in each direction with an electrically-operated, full-magnetic, across-the-line reversing type starter.] [Centrifugal switches shall be used in control circuit to prevent the plugging of trolley or bridge drive motors; each switch shall be arranged to set the associated drive's brake while attempts are made to plug.] [The [bridge] [and] [trolley] main control system shall be provided with reduced voltage starting for all speed points.]

b. Bridge and trolley main control systems shall be ac magnetic control, five-speed, reversing, plugging type.

c. Bridge and trolley main control systems shall be ac static stepless secondary saturable reactor. Control shall provide continuously-adjustable speed from minimum to full speed. Minimum speed with zero hook load shall not exceed 15 percent of full-rated speed. Control shall provide speed regulation of 15 percent or less from no-load to full-load at all speed settings.

d. Bridge and trolley main control systems shall be dc magnetic control type, five-speed, reversing, plugging type.

e. Bridge and trolley main control systems shall employ dc stepless, speed-regulated, adjustable-voltage control of dc shunt-wound motors. Control shall provide continuous-speed adjustment from minimum speed (2 percent at no hook load) to full speed. Control shall provide automatic-regenerative braking for speed reduction and slow down before brake setting. Control shall provide a minimum 50-to-1 speed range.

f. Bridge and trolley main central systems shall employ ac adjustable-frequency, speed-regulated, control of ac squirrel cage motors. Control shall provide continuous-speed adjustment from minimum speed (2.5 percent at no-hook load) to full-speed. Control shall provide automatic regenerative or dynamic braking for speed reduction and slow down before brake setting. Control shall provide a minimum 40-to-1 speed range with constant torque acceleration, for base and subbase speeds.

2.4.6.4   Drift Point

****

NOTE: Provide bridge and trolley directions normally oriented to main compass headings.

Select method of festoon suspension. For multiple girder cranes select underneath footwalk and for single girder cranes select auxiliary girder. If a hoist thermal sensor is specified, include requirement for yellow pilot light. If a micro-drive is specified, include the sentence, "A 2-position [_____]."

Pendant handles are required only if pendant is in an explosion area. Monorail cranes do not require an independent track for pendants.

****

Trolley and bridge main control systems shall have a drift point between OFF and first speed control point in each direction or shall have a separate pushbutton.

2.4.6.5   Micro-Drive Motor and Clutch Control

Micro-drive system shall be designed such that when micro-drive is selected at control station, all main motors shall be disconnected, and all micro-drive clutches shall be energized. Operation of micro-drive motors shall be from crane control station. Micro-motor control systems shall provide single-speed in each direction by means of an electrically-operated, full-magnetic, [reduced] [full] voltage type starter. Power shall not be applied to any micro-motor unless all clutches are fully engaged. If a clutch disengages during operation of micro-motors, the mainline contactors shall open and all brakes shall set. Application of power to any main motor shall be prevented with any clutch engaged. A transfer switch shall be provided at crane control station to allow transfer from either mode of operation to the other only when all brakes have been set for not less than 5 seconds. A single CLUTCH-ENGAGED green pilot light shall be provided [at the pendant station] [in the cab] when all clutches are energized; individual CLUTCH ENGAGED pilot lights shall be provided on drive control panels.

2.4.7 Cab Control Station

2.4.7.1 General

****

NOTE: Provide bridge and trolley directions normally oriented to main compass headings. If stepped speeds and/or drift point are specified, include the applicable requirements in this paragraph. Delete aux hoist switch if not necessary for the project.

****

Crane control shall be accomplished by a [bridge-mounted] [trolley-mounted] cab control. Master switch operating handles shall be spring-returned to OFF, [shall have distinct drift point detents,] [shall have distinct speed-point intents] and shall have OFF position latching. Master switch enclosures shall be NEMA Type 1. POWER-OFF pushbutton shall have a red mushroom head. POWER-ON pushbutton shall be green or black. Cab master switches shall be as follows:

a. Main Hoist - up/down.
b. Aux Hoist - up/down.
c. Bridge - [_____] [_____].
d. Trolley - [_____] [_____].
e. POWER-OFF.
f. POWER-ON.

2.4.7.2 Cab Indications

****

NOTE: If hoist thermal sensor is specified, include requirement for amber light. Voltmeter applicable to dc control systems only. If rail clamps are specified, include sentence regarding rail clamp operation and indication. If flood lighting is specified, include requirement for toggle switch.

****

Amber pilot lights to indicate excessive hoist motor temperature shall be provided. A white pilot light to indicate that power is available on load side of crane disconnect switch shall be provided. A blue pilot light shall be provided to indicate that the main contactor is energized. [A minus 300 to plus 300 Vdc voltmeter shall be supplied to monitor the main rectifier output voltage, a selector switch shall be provided to select the voltage to be monitored.] [A red pilot light shall be provided to indicate the rail clamps are set.] [A single-toggle switch shall be provided to operate crane floodlights.] [A single green pilot shall be provided to indicate all micro-drive clutches are engaged.]

2.4.7.3   Cab Controls

****
NOTE: Delete this paragraph if combination controls (cab and pendant or cab and radio control) are not used. If it is desirable to raise the pendant out of the way, include the last sentence. Otherwise, delete.
****

Cab shall be provided with a 2-position key-operated switch to allow transfer of control from cab to [pendant] [radio control] station and a red pilot light mounted in cab shall be provided to indicate that the control has been transferred to other station. Selection of one operating station shall lock out the controls of other stations. A 2-position switch shall be provided to raise and lower the pendant station.

2.4.8   Pendant Control Station

****
NOTE: Delete the following paragraphs if pendant control is not specified.

If pendant control is not specified, delete paragraphs. If the crane is higher than 18 m (60 feet) above the operating floor and the span is greater than 15 m (50 feet), consider including a pendant drive for ease of movement of the pendant if it is not towed by the trolley; otherwise delete this paragraph. Pendant drive speed should be the same as the trolley.
****

2.4.8.1   General

Pendant control station enclosure shall be NEMA Type [1] [3R] [7] [9] [12]. Physical size of pendant shall be held to a minimum. A separate cable of corrosion-resistant chain consisting of minimum 1/4 inch wire shall be provided. Pendant station shall be attached to [underside of crane bridge footwalk] [an auxiliary girder] and shall hang vertically with bottom of pendant at 40 inches above floor. Weight of pendant shall not be supported by control cable.

2.4.8.2   Operating Pushbuttons

****
NOTE: Delete requirement for auxiliary hoist pushbutton when no auxiliary hoist is used.
****

Operating pushbuttons shall be heavy-duty, dust-and-oil-tight type with distinctly-felt operating positions which meet requirements of NEMA ICS 2. Pendant control buttons shall be momentary pushbuttons. Pushbuttons (except the POWER-OFF button) shall be the recessed type to avoid accidental operation. Diameter of buttons shall be a size which will make operation possible with a thumb while holding the pendant with same hand. Nameplates shall be provided adjacent to each pushbutton. Barriers shall be provided on pendant between various pushbutton functions, except on elements mounted in junction box. In a multi-speed application, dual-position pushbuttons shall have a definite click-detent position for each speed. Pushbuttons shall be designed and manufactured not to hang up in control case. Pendant shall include a separate set of pushbuttons for each motion and for POWER-ON POWER-OFF. Pushbuttons shall be as follows:

POWER-OFF.
POWER-ON.
Hoist-up.
Hoist-down.
Bridge-[_____].
Bridge-[_____].
Trolley-[_____].
Trolley-[_____].
Auxiliary Hoist-up.
Auxiliary Hoist-down.

2.4.8.3 Light Indicators

****
NOTE: Coordinate requirement for pilot lights and selector switches.
****

Pilot lights shall meet heavy-duty requirements of NEMA ICS 2. One amber pilot light to indicate excessive hoist motor temperature shall be provided on pendant station. A blue pilot light shall be provided to indicate that the main contactor is energized, and a white pilot light to indicate that power is available on the load side of crane disconnect switch. A bright red mushroom head shall be provided with the POWER-OFF pushbutton. A 2-position selector switch shall be provided to select between normal and micro-drive. A single green pilot light shall be provided to indicate all micro-drive clutches are engaged.

2.4.8.4 Pendant Drive Control

A 3-position momentary contact spring-return to OFF toggle switch shall be provided to control the motorized trolley for pendant.

2.4.8.5 Transfer of Control Stations

Pendant shall be provided with a green pilot light to indicate that control has been transferred to pendant station from cab with key lock-out.

2.4.9 Radio Remote Control, Infrared Remote Control

****
NOTE: Include this paragraph if radio remote control or infrared remote control is desired; otherwise delete.
****

2.4.9.1 General

Crane shall be equipped with a complete digital radio remote-control system to permit full control of crane from a portable wireless transmitter. System shall be the use-proven product of a manufacturer regularly engaged in design and manufacture of crane radio remote-control systems. System shall be of a "fail-safe" design so that the failure of any component or loss of signal will cause all crane motors to stop. The system shall permit complete, independent and simultaneous operation of all crane functions. System frequency shall be in the 72MHz-76MHz band. Receiver shall include transfer relays if crane is also cab or pendant controlled.

2.4.9.2 Transmitter

****

NOTE: Provide bridge and trolley directions normally oriented to main compass headings. Delete requirement for auxiliary hoist control when no auxiliary hoist is used.

****

Transmitter shall be portable and complete with an adjustable belt or harness. Crane motion switches shall be spring-return to OFF. Transmitter shall be provided with two spare batteries and battery charger to permit continuous operation. A key-lock with the key removable in the OFF position only shall be provided to control transmitter operation. A blue signal light mounted on crane visible from floor shall be provided to indicate the main contactor is energized. POWER-OFF toggle-switch shall be bright red. Transmitter shall be provided with the following controls:

Hoist-up/down.
Bridge-[_____].
Trolley-[_____].
POWER-ON.
POWER-OFF.
Auxiliary Hoist-up/down.

2.4.10 Protection

2.4.10.1 Main Line Disconnect

A main line disconnect consisting of a combination circuit breaker (50,000 AIC) and non-reversing starter, starter without overloads (mainline contactor) in NEMA Type [_____] enclosure shall be provided. Mainline disconnect shall be controlled by a control circuit so that all crane motions will be stopped upon mainline undervoltage, overload, control circuit fuse failure, or operation of POWER OFF pushbutton. Mainline disconnect shall be equipped with energy isolating devices designed to accept lockout devices.

2.4.10.2 Isolation Transformer

****

NOTE: Specify an isolation transformer and surge protection to protect electronics from external faults. Recommended for dc static control systems. Applicable to ac power supplied systems only.

****

The isolation transformer shall be an SCR drive type specifically designed for cranes, with a continuous rating which will exceed that required of the sum of rated full-load full-speed KVA of hoist plus 50 percent of rated full-load full-speed KVA of trolley and bridge motors plus the rated KVA of controls. Total KVA is then multiplied by 1.05 (efficiency factor). The isolation transformer shall be connected to load side of mainline disconnect of the transformer. Crane dc static control electric power distributed on the crane shall be supplied through this isolation transformer.

2.4.10.3 Surge Protection

Surge suppressors shall meet the requirements of UL 1449. Three metal oxide varistors shall be provided on the line side of each SCR drive isolation transformer to provide transient over-voltage protection.

2.4.10.4 Circuit Breakers

Circuit breakers shall meet the requirements of UL 489.

2.4.10.5 Overloads

****
NOTE: Select applicable overload protection based on control circuit type.
****

[Alternating current circuit overload relays shall be of the ambient compensated, automatic reset, inverse time type located in all phases individual motor circuits. Overload relays shall be arranged to de-energize the associated motor on an overload condition.] [An automatically reset inverse time-trip running overload relay shall be provided for each dc motor circuit. An automatically reset instantaneous trip overload relay shall be provided in each dc motor circuit or for a pair of series-connected motors. Overload relays shall be arranged to de-energize the associated motor on an overload condition.] [Alternating current adjustable frequency-control motor overload-protection shall be electronic and shall protect by inverse time and current versus output frequency which will allow less current for a given amount of running time when frequency (speed) is lower than rated.] [Direct current variable voltage control motor overload-protection shall be electronic.]

2.4.11 Limit-Switches

****
NOTE: Delete reference to micro-drive control system if not applicable.
****

Geared limit-switches shall be heavy-duty quick-break double-pole double-throw type conforming to NEMA ICS 2. The geared limit-switch interruption of a motion in one direction shall not prevent the opposite motion. Geared limit-switches shall reset automatically. Limit-switch housings shall be NEMA Type [1] [4]. Limit-switches shall interrupt power to the primary and micro-drive control systems.

2.4.11.1 Hoist Upper Limit-Switches

Two limit-switches shall be provided for each hoist. A rotating-type adjustable geared-control circuit interrupt limit-switch shall provide hoist-up limiting. A secondary hoist-upper-limit shall be provided with a weight-operated power circuit limit-switch to prevent the hoist from raising beyond the safe limit. The secondary limit-switch shall operate to interrupt power to all hoist motor conductors, set the hoist holding brakes and directly open all "raise" power circuits. [A power bypass contactor and operator button to permit backing out and resetting of power limit-switch shall be provided for ac adjustable frequency control.] [A power bypass contactor and operator button to permit backing out and resetting of power limit-switch shall be provided for dc variable-voltage control.]

2.4.11.2 Hoist Lower Limit-Switches

Hoists shall be provided with a rotating-type adjustable geared-control circuit interrupt limit-switch for hoist-down travel limiting. The hook downward vertical travel of the hook shall be field-adjustable to approximately 6 inches above working surface.

2.4.11.3 Bridge and Trolley Travel Limit-Switches

Runway (track-type) limit-switches shall be provided for crane bridge and trolley motions to stop the bridge and trolley motions, respectively. Limit-switch actuators shall be installed on building and trolley frame to actuate the limit-switches and stop the crane bridge or trolley prior to contacting the trolley frame bumpers. Trip mechanism for trolley motion shall be located on crane runway to trip the switch before the bumper contacts the stop. Trip mechanism for bridge motion shall be located on crane runway to trip switch before bumper contacts the stop. When the switch is tripped, the switch shall permit opposite travel in the direction of stop and then automatically reset.

2.4.11.4 Rail Clamp Limit-Switches

****

NOTE: Include paragraph for outdoor cranes; otherwise delete. Delete reference to micro-drive when not applicable.

****

When rail clamps are set, each rail clamp shall be furnished with a limit-switch designed to interrupt the primary and micro-drive control circuits to bridge drive. A red pilot light shall be provided at control station to indicate the rail clamps are set.

2.4.12 Wiring

Wires shall be numbered or tagged at connection points. Splices shall be made in boxes or panels on terminals boards or standoff insulators. Motor loop, branch circuit and brake conductor selection shall be based on NFPA 70 for 90 degree C conductor rating on indoor cranes, and for 75 degree C conductor rating on outdoor cranes. Wire insulation shall be Type XHHW. Conductors in the vicinity of resistors and conductors connected to resistors shall be Type 5RML.

2.4.13 Electrification

2.4.13.1 Main Power Electrification

Main power electrification system shall provide power to crane starter/disconnect circuit breaker.

2.4.13.2   Crane Runway Conductors

****

NOTE: Select covered conductor bar system for:

a. Indoor non-hazardous service

b. Outdoor non-corrosive environment

Select festoon system for:

a. Indoor - hazardous service

b. Outdoor - corrosive (marine) environment

****

[Crane runway conductor system shall be the covered conductor bar system type designed and manufactured to meet UL requirements. Protective covers shall be the rigid or flexible self-closing type designed to cover all live conductors and shall be shaped to prevent accidental contact with conductors. Collectors shall be heavy-duty sliding shoe type compatible with the electrification system. Two tandem designed collector heads shall be provided for each conductor rail to provide redundancy.] [Crane runway conductor system shall be the festooned type consisting of a support rail, cables, junction boxes, cable cars and accessories. Hardware shall be corrosion-resistant or protected against corrosion. Festoon storage area shall not restrict the crane travel at the ends of runway.]

2.4.13.3   Bridge Span Conductors

Bridge span conductor system shall be the [festooned type consisting of a support rail, electrical cables, junction boxes, cable cars and accessories] [rigid conductor/collector type]. Cable loops shall not drop below the hook high position. Outdoor crane bridge festoon system hardware shall be corrosion resistant.

2.4.13.4   Pendant Festoon System

****

NOTE: The pendant festoon system is an option to the Designer.

****

Pendant festoon system shall consist of a support rail, cables, junction boxes, cable cars and accessories. Cable loops shall not drop below the hook high position. Pendant control car shall be provided with NEMA Type [1] [3R] [12] junction box. Pendant festoon shall be [towed by trolley] [independent of trolley motion]. Outdoor crane pendant festoon system hardware shall be corrosion resistant.

2.4.13.5   Pendant Drive System

****

NOTE: For pendant control cranes and cab controlled

cranes where hydraulic braking is not desired, select spring-applied electrically-released brakes. For cab operated cranes, electric-hydraulic brakes should be specified for bridge or trolley brakes except in the case of constant speed/speed regulated (at a particular controller setting) type controls

Electric-hydraulic brakes should be limited to ac magnetic or secondary saturable reactor and dc magnetic controls for ac wound rotor motors and dc series/compound wound motors respectively. Electric-hydraulic brakes should be limited to bridge brakes on bridge mounted cabs and trolley brakes for trolley mounted cabs.

Electric-hydraulic brakes should not be specified for the following:

a. Single and multi-speed magnetic control of squirrel cage motors.

b. Alternating current adjustable frequency control of squirrel cage motors.

c. Direct current variable voltage control of shunt wound ac motors.
****

Pendant festoon system shall be provided with a motor-drive system capable of driving the pendant control car at [_____] fpm. Pendant motor drive shall be controlled from the pendant.

2.4.13.6 Pendant Retraction System

****
NOTE: Select method of pendant retraction if specified; otherwise delete paragraph.
****

[Pendant control car shall be provided with an electric-powered cable reel so that the pendant station will retract fully.] [A wire-rope hoist shall be provided to hoist the pendant station. Pendant and pendant drop-cable shall be retractable to approximately 1/3 of drop cable length.] Retraction system shall be controlled from cab.

2.4.14 Special Requirements

2.4.14.1 Warning Horn

****
NOTE: Delete last sentence if not applicable to project.
****

A solid-state electronic warning horn shall be provided on the crane. Any bridge or trolley motion shall be accompanied by a continuous series of alternating tones. The warning horn shall not sound when the crane is in the micro-drive mode.

2.4.14.2 Accessory Power

****
NOTE: If lighting, motor or control cabinet heaters or receptacles are specified, include the following paragraph if 460 volt ac is the power source. Select the components requiring power.
****

Three-phase 208Y/120 volt ac power supplied via a circuit breaker and isolation transformer from the line side of the main line disconnect shall be used for [lighting,] [heaters,] [and accessory circuits] on the crane. The circuit breaker shall have a NEMA Type [1] [3R] [12] enclosure. The enclosure shall have provisions to lock the breaker in the OFF position. Each circuit breaker pole shall have individual thermal and magnetic trip elements, and the enclosure cover shall be complete with a button for mechanically tripping the circuit breaker. A three-phase 480 volt delta primary and 208Y/120 volt wye secondary general lighting transformer shall be supplied from the accessory circuit breaker and shall feed a 208Y/120 volt UL listed circuit breaker panelboard and a heater circuit breaker/combination starter. The panelboard shall supply branch circuits for utilization of various accessories such as [receptacles,] [lighting] [panel internal lighting] [motor heaters and control enclosure which meets NEMA requirements]. Transformer and panelboard shall have the same NEMA classification as the circuit breaker.

2.4.14.3 Receptacles

****
NOTE: Specify receptacles for multiple girder cranes. Specify ground fault protection for outside cranes. Delete requirement for receptacle in cab when not applicable.
****

Receptacles shall be single-phase, 120-volt 15-amp, grounded, duplex types complete with metal weather-proof enclosure with self-closing weatherproof receptacle cover. A receptacle shall be provided on the trolley at each end of the front bridge walkway in the vicinity of bridge travel drive motors and in the cab. Several receptacles shall be provided in the vicinity of the control equipment equally spaced every 10 feet. Breakers used to protect circuits supplying the receptacles for outside cranes shall incorporate ground fault current interruption feature and meet the requirements of UL 943.

2.4.14.4 Lighting

****
NOTE: Specify lighting for outdoor cranes or in dimly lighted areas.
****

Control panels shall be provided with a 120-volt lamp fixture with an unbreakable lens and switch. Floodlights shall be provided to illuminate the work area under the crane and drum area on crane and shall be controlled from crane control station. Floodlights shall be metal halide industrial luminaries. Each floodlight shall be totally enclosed, vapor-tight design, gasketed and shall be provided with a heat-resistant and impact-resistant glass lens. Floodlights shall be spaced and attached to underside of crane to provide uniform lighting.

2.4.14.5 Anti-Condensation Heaters

****

NOTE: Motor heaters recommended for outdoor cranes, unheated warehouse service cranes or any other condensing high-humidity application; if not desired delete this paragraph. Thermostatically-controlled heaters is a designer option.

****

Motor and control panels shall be equipped with anti-condensation heaters. Thermostatically-controlled heaters shall be provided in each static-control panel to keep control enclosure temperatures at or above 0 degrees C. Circuit breaker combination magnetic starter shall be NEMA Type [1] [3R] [12] enclosure. Magnetic starter shall be equipped with manually-reset overload relays and interlocked with the mainline disconnect so that anti-condensation heaters are de-energized when the mainline contactor is energized and the magnetic starter is energized when the mainline contactor is de-energized.

2.4.14.6 Wind Indication and Alarm

****

NOTE: Specify location of wind alarm station for outdoor cranes, normally mounted near center of the bridge. Provide location of cutout. Delete paragraph if not applicable.

****

A wind-indicating device with an adjustable alarm trip point shall be provided. Alarm trip shall have time-delay for wind gusts. Adjustable trip shall actuate an oscillating blue light and bell mounted near [_____]. Bell shall have the ability to be cut from the [pendant station] [cab].

2.4.14.7 Electrically-Driven Oil Pump Alarm

Electrically-driven lubricating pump shall be complete with an audible alarm and red light for indication of pump malfunction. Location of alarm shall be the factory standard location.

2.4.15 Load-Limit System

****

NOTE: Specify load sensing if loads approaching the capacity of the crane are to be lifted routinely.

****

A load-limit visual/audible system shall be provided for the main hoist to inform the operator that the preset load has been exceeded. The load-limit system shall consist of a load-cell, load-sensing electronics, overload indicator lights, overload alarm bell and alarm cut-out switch. Load cell shall be mounted to receive the load from equalizing sheave pin or upper block sheave pin.

2.4.15.1 Load-Sensing Electronics

Load-sensing electronics shall be NEMA Type [1] [3R] [12] enclosures. Alarm setpoint shall be adjustable.

2.4.15.2 Alarm and Indicator Light

An overload alarm light shall be provided to indicate a load greater than the preset maximum. Overload alarm shall be indicated with a red light and clearly labeled "OVERLOAD". A bell shall be provided to indicate when an overload condition exists. Provision shall be made to turn off the bell.

2.4.16 Cab Heating and Ventilating [and Air-Conditioning]

****

NOTE: If heating or air conditioning of the cab is required, edit this paragraph to specify design requirements; otherwise delete this paragraph. Refer to TM-5-785 or AFM 88-29 ambient temperatures for cab heating and air conditioning.

****

Cab shall be thermally-insulated and shall be provided with air-conditioner and electric heater. A filter unit shall pressurize the cab with filtered outside air. Air filter shall be a standard commercial type capable of removing airborne dust and shall be located where it can be readily cleaned or changed. Air conditioner with heater shall be controlled with an adjustable thermostat. The unit shall meet the Energy Efficient requirements of ASHRAE 90.1. The cab interior shall be maintained at 65 degrees F in winter with [_____] degrees F ambient temperature and [_____] degrees F in summer with [_____] degrees F dry bulb and [_____] degrees F wet-bulb ambient temperatures. All other hardware and components shall be of corrosion-resistant material or protected against corrosion. Motor compressor assembly shall be mounted on vibration isolators.

2.4.17 Fungus Resistance

****

NOTE: Specify fungus resistance for cranes in marine or humid environments.

****

Electrical connections such as terminal connections, circuit connections, components and circuit elements shall be coated with fungus-resistant varnish. Components and elements inherently inert to fungi or hermetically sealed shall not be treated. Elements whose operation will be adversely affected with the application of varnish shall not be treated.

2.5 ELECTROMAGNETIC INTERFERENCE SUPPRESSION

****

NOTE: Specify EMI suppression if electro-magnetic interference from the crane may be a problem to sensitive electronics in the work area.

****

2.5.1 Shielded Cable

Pendant and festooned cables shall be the shielded type of braided tinned-copper. Each cable shielding shall be grounded with a single connection to equipment grounding conductor.

2.5.2 EMI/RFI Shielded Boxes

2.5.2.1 General

Boxes designed to house electronic and electrical control equipment, instruments, metering equipment, etc., in installations where electromagnetic compatibility and/or system security is required shall protect interior components from stray radio frequency (RF) fields and shall contain RF signals produced by interior components.

2.5.2.2 Construction

Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) shielded boxes shall be designed to meet UL 50 Type 12 and Type 13. The shielded boxes shall be constructed of [16] [14] gauge steel with seams continuously welded and ground smooth, without holes and knockouts. Cover gasket shall be a combination of woven plated steel mesh and oil-resistant gasket which will provide an EMI/RFI seal as well as an oil-tight, dust-tight and water-tight seal between cover and body. Gasket shall be attached to cover with oil-resistant adhesive. Stainless steel cover clamps and screws which are quick and easy to operate shall be provided on three sides of hinged cover for positive clamping.

2.5.2.3 Attenuation

EMI/RFI shielded boxes shall be designed to provide maximum shielding of electric and magnetic components of radiated RF energy. RF filters shall be provided to suppress conducted radio frequency in cables and conductors. Shielded boxes shall provide attenuation greater than 60 db at 14.5 KHz to greater than 100 db at 1 MHz for magnetic fields and greater than 100 db from 14.5 KHz to 430 MHz for electric fields.

2.5.2.4 Finish

EMI/RFI shielded boxes shall be zinc-plated in accordance with ASTM B 633 SC3/Type II to provide corrosion-resistant conductive surfaces for gasket contact area and conduit entries. The finish coat shall match the crane finish.

2.5.3 Drum Grounding

****

NOTE: A grounding drum is required for non-sparking environment only (general nuclear or explosive).

****

A copper ring/collector assembly shall be provided to ground each drum. Ring shall be electrically-bonded to drum. Collector shall be stationary and connected to equipment grounding conductor system with a No. 8 AWG copper wire.

PART 3 EXECUTION

3.1 ERECTION

The entire crane erection shall be performed in accordance with manufacturer's instructions under the full-time supervision of the manufacturer's representative. Contractor shall provide a written certificate from crane manufacturer indicating the crane is erected in accordance with manufacturer's recommendations before testing the completed installation.

3.1.1 Shop Assembly

Major crane components shall be shop assembled as completely as possible. Disassembled parts shall be match marked and electrical connections tagged after complete no-load shop testing. Parts and equipment at site shall be protected from weather, damage, abuse and loss of identification. Erection procedures shall ensure that the crane is erected without initial stresses, forced or improvised fits, misalignments, nicks of high-strength structural steel components, stress-raising welds and rough burrs. Damaged painted surfaces shall be cleaned and repainted after crane is erected.

3.1.2 Mechanical Alignment

Motors, couplings, brakes, gear boxes and drive components shall be aligned when reinstalled in accordance with manufacturer's instructions.

3.1.3 Electrical Alignment

Control system shall be aligned in accordance with manufacturer's instructions. A copy of the final alignment data shall be stored in control panel door and shall include but not be limited to timer settings, resistor tap settings, potentiometer settings, test-point voltages, supply voltages, motor voltages, motor currents and test conditions such as ambient temperature, motor load, date performed and person performing the alignment.

3.1.4 Welding

Welders, welding operations and welding procedures shall be qualified or prequalified in accordance with AWS D14.1. Welding shall be performed indoors and the surface of parts to be welded shall be free from rust, scale, paint, grease or other foreign matter. Minimum preheat and interpass temperatures shall conform to the requirements of AWS D14.1. Welding shall be performed in accordance with written procedures which specify the Contractor's standard dimensional tolerances for deviation from camber and sweep. Such tolerances shall not exceed those specified in accordance with AWS D14.1. Allowable stress ranges shall be in accordance with MHI CMAA 70. Welding of girders and beams shall conform with AWS D14.1.

3.1.5 Field Painting

****

NOTE: The last sentence will only be required if the bridge crane is in an explosion proof area.

****

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the facility, shall be as specified in Section 09900 PAINTING, GENERAL. Bridge crane including bridge, trolley, hoist and all attached items shall be painted in accordance with the manufacturer's standard practice. The complete crane shall be of one color. Bridge rail, supports and bracing shall be painted in accordance with Section 09900 PAINTING, GENERAL. Items such as surfaces in contact with the rail wheels, wheel tread, hooks, wire rope, surfaces on the electrical collector bars in contact with the collector shoes and nameplates shall not be painted. The requirements of explosion proof cables shall be coordinated with cable manufacturer.

3.2 ACCEPTANCE TESTING

3.2.1 General

****

NOTE: This paragraph applies to new construction only. Specify the test weights required. The weights normally required are the rated load, 125 percent of the rated load and 10 percent of the rated load (for the grounding and the acceleration/deceleration test).

****

Contractor shall provide all personnel necessary to conduct the required testing which shall include but not be limited to crane operators, riggers, rigging gear and test weights. Testing shall be performed in the presence of Contracting Officer or his designated representative. Contractor shall notify Contracting Officer [_____] days prior to testing operations. Contractor shall operate all equipment and make all necessary corrections and adjustments prior to the testing operations witnessed by Contracting Officer. A representative of the Contractor responsible for procuring and installing hoist equipment shall be present to direct the field testing. Test loads shall be compact and permit a minimum of 50 percent of vertical lift. Test loads shall be minus 0 percent to plus 5 percent of the required weight, and shall be verified prior to testing. Test weights required are [_____] pounds, [_____] pounds and [_____] pounds. Operational testing shall not be performed until after building interior has been painted. [Three] [_____] copies of all test reports shall be furnished to Contracting Officer.

3.2.1.1 Test Sequence

Crane shall be tested in accordance with applicable paragraphs of this procedure in the sequence provided.

3.2.1.2 Test Data

Operating and startup current measurements shall be recorded for coils, hoist, trolley, and bridge motors using the appropriate instrumentation. Speed measurements shall be recorded as required by facility evaluation tests (normally at 100 percent load). Recorded values shall be compared with design specifications or manufacturer's recommended values and the abnormal differences shall be justified in the remarks or appropriate adjustments performed. The high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated and corrected. Hoist, trolley and bridge speeds shall be recorded during each test cycle.

3.2.1.3 Equipment Monitoring

Improper operation or poor condition of safety devices, electrical components, mechanical equipment and structural assemblies shall be monitored during the load test. Defects observed to be critical during the testing period shall be reported immediately to the Contracting Officer and the testing operations shall be suspended until the defects are corrected. During each load test and immediately following each load test, the following inspections shall be made:

a. Inspect for evidence of bending, warping, permanent deformation, cracking or malfunction of structural components.

b. Inspect for evidence of slippage in wire rope sockets and fittings.

c. Check for overheating in brake operation; check for proper stopping. All safety devices including emergency stop switches and POWER-OFF pushbuttons shall be tested and inspected separately to verify proper operation of the brakes. When provided, safety accessories including warning horn, lighting, gauges, warning lights and accuracy of wind indicating device and alarm shall be inspected.

d. Check for abnormal noise or vibration and overheating in machinery drive components.

e. Check wire rope sheaves and drum spooling for proper reeving and operation, freedom of movement, abnormal noise or vibration.

f. Check electrical drive components for proper operation, freedom from chatter, noise, overheating, and lockout/tagout devices for energy isolation.

g. Inspect gears for abnormal wear patterns, damage, or inadequate lubrication.

h. Verify that locations of crane capacity plates are visible from pendant operator's position.

3.2.1.4 Hooks

Hooks shall be measured for hook throat spread before and after load test. A throat dimension base measurement shall be established by installing two tram points and measuring the distance between the tram points to within 1/64 inch. This base dimension shall be recorded. Distance between tram points shall be measured before and after load test. An increase in throat opening by more than 1 percent from base measurement shall be cause for rejection.

3.2.2 No-Load Testing

****
NOTE: Delete references to micro-drive when not applicable.
****

3.2.2.1 Hoist Operating and Limit Switch Test

Load hook shall be raised and lowered through the full range of normal travel at rated speed and other crane speeds. Load hook shall be stopped below the geared limit-switch upper setting. In slow speed only, proper operation of upper and lower limit-switches for primary and micro-drive motions shall be verified. The test shall be repeated a sufficient number of times (minimum of 3) to demonstrate proper operation. Brake action shall be tested in each direction. Proper time-delay shall be verified between the actuation of dual brakes.

3.2.2.2 Trolley Travel

****
NOTE: Delete references to micro-drive when not applicable.
****

Trolley shall be operated the full distance of bridge rails exercising all primary drive and micro-drive speed controls in each direction. Brake operation shall be verified in each direction. In slow speed or micro-drive, trolley bumpers shall contact trolley stops located on the bridge girders. In slow speed the proper operation (interrupt power, automatic reset) of the trolley limit-switches at both limits of trolley motion shall be tested.

3.2.2.3 Bridge Travel

****
NOTE: Delete references to micro-drive when not applicable.
****

Bridge shall be operated in each direction the full distance of runway exercising all primary drive and micro-drive speed controls. Brake operation shall be verified in each direction. [In slow speed the proper operation (interrupt power, automatic reset) of the bridge limit-switches at both limits of bridge motion shall be tested.] In slow speed or micro-drive the crane bridge bumpers shall contact the runway rail stops.

3.2.2.4 Hoist Loss of Power No-Load Test

Using the primary drive, hooks shall be raised to a height of approximately 12 feet or less. While slowly lowering the hook the main power source shall be disconnected, verifying that the hook will not lower and that both brakes will set. Test shall be repeated using micro-drive controls.

3.2.2.5 Travel Loss of Power No-Load Test

With the hook raised to clear obstructions and trolley traveling in slow speed, the main power source shall be disconnected, verifying that the trolley will stop and the brake will set. Test shall be repeated for trolley using micro-drive speed. Test shall be repeated for bridge, micro-drive and slow speed primary drive controls.

3.2.3 Load Test

****
NOTE: Delete references to micro-drive when not applicable.
****

3.2.3.1 Hoist

Unless otherwise indicated, the following tests shall be performed using a test load of 125 percent (plus 5 percent, minus 0 percent) of rated load.

a. Hoist Static Load Test: Holding brakes and hoisting components shall be tested by raising the test load approximately 1 foot and manually releasing one of the holding brakes. Load shall be held for 10 minutes. First holding brake shall be reapplied and second holding brake released. Load shall be held for 10 minutes. Any lowering that may occur indicates a malfunction of brakes or lowering components.

b. Dynamic Load Test: Test load shall be raised and lowered through the full range operating in each speed. Machinery shall be completely stopped at least once in each direction to ensure proper brake operation.

c. Hoist Mechanical Load Brake: With test load raised approximately 5 feet and with the hoist controller in the neutral position, holding brake shall be released. Mechanical load brake shall be capable of holding the test load. With holding brake in released position, test load shall be lowered (first point) and the controller shall be returned to OFF position as the test load lowers. Mechanical load brake shall prevent the test load from accelerating.

d. Hoist Loss of Power Test: After raising test load to approximately 8 feet, slowly lowering the test load, the main power source and control pushbutton shall be released verifying that the test load will not lower and that both brakes will set. Test shall be repeated using micro-drive controls.

e. Trolley Dynamic Load Test: While operating the trolley the full distance of bridge rails in each direction with test load on the hook (one cycle), proper functioning of all primary drive and micro-drive speed control points and proper brake action shall be tested.

f. Bridge Dynamic Load Test: With test load on hook, bridge shall be operated for the full length of runway in both directions with trolley at each extreme end of bridge. Proper functioning of all primary drive and micro-drive speed control points and brake action shall be verified.

3.2.3.2 Trolley and Bridge Loss of Power Test

A test load of 100 to 105 percent of rated load shall be raised clear of any obstructions on operating floor. Starting at a safe distance from walls or other obstructions, a slow speed shall be selected using the trolley and bridge primary drive. While maintaining a safe distance to obstructions, the main power source shall be disconnected and brakes shall be verified to have set and that the equipment stops within the distance recommended by manufacturer.

3.2.4 Overload Tests

After the operational tests, bridge crane system and all functions of bridge crane shall be tested at 125 percent of rated load.

3.2.5 Acceleration and Deceleration Tests

The acceleration and deceleration of bridge and trolley shall be tested with approximately 10 percent of rated load at lowest possible location of hook. Bridge and trolley shall be operated to run up to high speed and then stopped without jarring or swinging the load.

3.2.6   Grounding Test

Hoist shall be tested to determine that the hoist, including hook and pendant, are grounded to building during all phases of hoist operation. The grounding of bridge and trolley shall be tested with approximately 10 percent of rated load on hook. Grounding shall be tested between hoist hook and the structure's grounding system.

3.2.7   Adjustments and Repairs

Adjustments and repairs shall be performed by Contractor under the direction of the Contracting Officer at no additional cost to the Government, until satisfactory conditions are maintained, and contract compliance is affected. After adjustments are made to assure correct functioning of the components, pertinent testing shall be repeated.

3.3   SCHEMATIC DIAGRAMS

Schematic diagrams for equipment shall be stored where indicated on drawings.

3.4   MANUFACTURER'S FIELD SERVICE REPRESENTATIVE

Contractor shall furnish a qualified experienced manufacturer's field service representative to supervise the crane installation, assist in the performance of the on site testing, and instruct personnel in the operational and maintenance features of the equipment.

3.5   FIELD TRAINING

Contractor shall conduct a training course for the operating staff. Training period shall consist of a total of [_____] hours of normal working time and shall start after the system is functionally completed but prior to final acceptance. Course instructions shall cover pertinent points involved in operating, starting, stopping, and servicing the equipment, including all major elements of operation and maintenance manual. Course instructions shall demonstrate all routine maintenance operations such as lubrication, general inspection, and [_____]. Contracting Officer shall be given at least 2 weeks advance notice of field training.

3.6   ACCEPTANCE

****

NOTE: This paragraph should be used as written for projects where the crane is the principal construction element, or represents a very significant portion of the Contract cost. However, if the crane is part of a new facility or renovation, the acceptance paragraph should be deleted from this section. Warranty period and operating and maintenance processes should not be started before the actual beneficial occupancy of the entire facility.

****

Final acceptance of crane system will not be given until Contractor has successfully completed all testing operations, corrected all material and equipment defects, made all proper operation adjustments, and removed paint or overspray on wire rope, hook and electrical collector bars.

-- End of Section --

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 15080

THERMAL INSULATION FOR MECHANICAL SYSTEMS
03/99

****

NOTE: This guide specification covers the requirements for field applied thermal insulation on mechanical systems; interior and exterior; above and below ground. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for pipe insulation, duct insulation, and equipment insulation. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. At the discretion of the government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 580/A 580M	(1995a) Stainless Steel Wire
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C 195	(1995) Mineral Fiber Thermal Insulating Cement
ASTM C 449/C 449M	(1995) Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C 518	(1991) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 533	(1995) Calcium Silicate Block and Pipe Thermal Insulation
ASTM C 534	(1994) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 547	(1995) Mineral Fiber Pipe Insulation
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 553	(1992) Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 610	(1995) Molded Expanded Perlite Block and Pipe thermal Insulation
ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation
ASTM C 665	(1995) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C 647	(1995) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C 795	(1992) Thermal Insulation for Use in

	Contact With Austenitic Stainless Steel
ASTM C 916	(1985; Rev 1996) Adhesives for Duct Thermal Insulation
ASTM C 920	(1995) Elastomeric Joint Sealants
ASTM C 921	(1989 R; 1996) Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM C 1126	(1996) Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM C 1136	(1995) Flexible, Low Permeance Vapor retarders for Thermal Insulation
ASTM C 1290	(1995) Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HV AC Ducts
ASTM E 84	(1997a) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(1993) National Commercial & Industrial Insulation Standards

1.2 SYSTEM DESCRIPTION

****

NOTE: This guide specification is to be used for field applied insulation on mechanical systems; interior and exterior, above and below ground. Insulation for energy distribution systems covered by Section 02552 PRE-ENGINEERED UNDERGROUND HEAT DISTRIBUTION SYSTEM, Section 02553 HEAT DISTRIBUTION SYSTEMS IN CONCRETE TRENCHES, Section 02555 PREFABRICATED UNDERGROUND HEATING/COOLING DISTRIBUTION SYSTEM, and Section 02554 ABOVEGROUND HEAT DISTRIBUTION SYSTEM, are not within the scope of this guide specification. Heating, air conditioning, and evaporative cooling duct; equipment; and piping are included. Pipe insulation is covered between minus 34 degrees C and plus 204 degrees C (minus 30 degrees F and plus 400 degrees F). Equipment insulation is covered between minus 34 degrees C and plus 982 degrees C (minus 30

degrees F and plus 1800 degrees F).
****

Field-applied insulation and accessories on mechanical systems shall be as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Insulation of heat distribution systems and chilled water systems outside of buildings shall be as specified in Section 02552 PRE-ENGINEERED UNDERGROUND HEAT DISTRIBUTION SYSTEM, Section 02553 HEAT DISTRIBUTION SYSTEMS IN CONCRETE TRENCHES, Section 02554 ABOVEGROUND HEAT DISTRIBUTION SYSTEM, and Section 02555 PREFABRICATED UNDERGROUND HEATING/COOLING DISTRIBUTION SYSTEM. Field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS shall be furnished and installed by the Contractor.

1.3 GENERAL QUALITY CONTROL

1.3.1 Standard Products

Materials shall be the standard products of manufacturers regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.3.2 Installer's Qualifications

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

1.3.3 Surface Burning Characteristics

Unless otherwise specified, insulation not covered with a jacket shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Insulation systems which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Insulation materials located exterior to the building perimeter are not required to be fire-rated. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets , facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

1.3.4 Identification of Materials

Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material.

1.4 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item

should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO "when the submittal is for information only.

SD-14: Designer will exclude ductwork insulation display samples for small, simple projects where the extent of duct insulation is not likely to cause a problem of enforcement with the requirements of the specification.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-14 Samples

Thermal Insulation Materials; [_____].

A complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories for each mechanical system requiring insulation shall be included. Materials furnished under this section of the specification shall be submitted at one time.

After approval of materials and prior to applying insulation a booklet shall be prepared and submitted for approval. The booklet shall contain marked-up MICA Insulation Stds plates (or detail drawings showing the insulation material and insulating system) for each pipe, duct, or piece of equipment required to be insulated per this specification. The MICA plates shall be marked up showing the materials to be installed in accordance with the requirements of this specification for the specific insulation application. The Contractor shall submit all MICA Plates required to show the entire insulating system, including Plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. If the Contractor elects to submit detailed drawings instead of marked-up MICA Plates, the detail drawings shall show cut-away, section views, and details indicating each component of the insulation system and showing provisions for insulating jacketing, and sealing portions of the equipment. For each type of insulation installation on the drawings, provide a label which identifies each component in the installation (i.e., the duct, insulation, adhesive, vapor retarder, jacketing, tape, mechanical fasteners, etc.) Indicate insulation by type and manufacturer. Three copies of the booklet shall be submitted at the jobsite to the Contracting Officer. One copy of the approved booklet shall remain with the insulation Contractor's display sample and two copies shall be provided for Government use.

After approval of materials actual sections of installed systems properly insulated in accordance with the specification requirements shall be displayed. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. Display sample sections will be inspected at the jobsite by the Contracting Officer. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

Pipe Insulation Display Sections: Display sample sections shall include as a minimum an elbow or tee, a valve, dielectric unions and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

Duct Insulation Display Sections: Display sample sections for rigid and flexible duct insulation used on the job. A display section for duct insulation exposed to weather shall be protected by enclosing with a temporary covering.

1.5 STORAGE

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. Insulation material and supplies that become dirty, dusty, wet, or otherwise contaminated may be rejected by the Contracting Officer.

PART 2 PRODUCTS

2.1 GENERAL MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:

2.1.1 Adhesives

2.1.1.1 Acoustical Lining Insulation Adhesive

Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C 916, Type I.

2.1.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C 195.

2.1.1.3 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. Lagging adhesives shall be nonflammable and fire-resistant and shall have a flame spread rating no higher than 25 and a smoke developed rating no higher than 50 when tested in accordance with ASTM E 84. Adhesive shall be pigmented [white] [red] and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bounding fibrous glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations.

2.1.2 Contact Adhesive

Adhesive may be dispersed in a nonhalogenated organic solvent or, dispersed in a nonflammable organic solvent which shall not have a fire point below 200 degrees F. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The adhesive shall be nonflammable and fire resistant.

2.1.3 Caulking

ASTM C 920, Type S, Grade NS, Class 25, Use A.

2.1.4 Corner Angles

Nominal 0.016 inch aluminum 1 x 1 inch with factory applied kraft backing. Aluminum shall be ASTM B 209, Alloy 3003, 3105, or 5005.

2.1.5 Finishing Cement

Mineral fiber hydraulic-setting thermal insulating cement ASTM C 449/C 449M. All cements that may come in contact with Austenitic stainless steel must include testing per ASTM C 795.

2.1.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth and glass tape shall have flame spread and smoke developed ratings of no greater than 25/50 when measured in accordance with ASTM E 84. Tape shall be 4 inch wide rolls. Class 3 tape shall be 4.5 ounces per square yard.

2.1.7 Staples

Outward clinching type [monel] [ASTM A 167, Type 304 or 316 stainless steel]. Monel is a nickel rich alloy which has high strength, high ductility, and excellent resistance to corrosion.

2.1.8 Jackets

****

NOTE: Type I is a vapor retarder for use over insulation on pipes, ducts, or equipment operating at temperatures below ambient at least part of the time or wherever a vapor retarder is required. Type II is water vapor permeable and for use over pipes, ducts, or equipment operating above ambient temperatures or wherever a vapor retarder is not

required.
****

ASTM C 921, Type I, maximum moisture vapor transmission 0.02 perms, (measured before factory application or installation), minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pound/inch width. ASTM C 921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pound/inch width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing. Based on the application, insulation materials which require factory applied jackets are mineral fiber, cellular glass, and phenolic foam. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84.

2.1.8.1 White Vapor Retarder All Service Jacket (ASJ)

For use on hot/cold pipes, ducts, or equipment vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

2.1.8.2 Aluminum Jackets

Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B 209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105 with factory applied moisture retarder. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch and larger diameter. Aluminum jacket circumferential seam bands shall be 2 x 0.016 inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4 x 0.020 inch) thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburg or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

2.1.8.3 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, UV resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch. Insulation under PVC jacket shall meet jacket manufacturer's written recommendations.

2.1.9 Vapor Retarder Coating

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall be determined according to procedure B of ASTM E 96 utilizing apparatus described in ASTM E 96. The coating shall be a nonflammable, fire resistant type. All other application and service properties shall be in accordance with ASTM C 647.

2.1.9.1 Vapor Retarder Required

ASTM C 1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable.

2.1.9.2 Vapor Retarder Not Required

ASTM C 1136, Type III, maximum moisture vapor transmission 0.10 perms, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable.

2.1.10 Wire

Soft annealed ASTM A 580/A 580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2 PIPE INSULATION MATERIALS

Pipe insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.2.1 Aboveground Cold Pipeline

Insulation for minus 30 degrees to plus 60 degrees F shall be as follows:

2.2.1.1 Outdoor, Indoor - Exposed or Concealed

2.2.1.1.1 Cellular Glass

ASTM C 552, Type II, and Type III. Supply the insulation with manufacturers recommended factory applied jacket.

2.3 Flexible Cellular Insulation

ASTM C 534, Type I or II. Type II shall have vapor retarder skin on both sides of the insulation.

2.4 Phenolic Insulation

ASTM C 1126, Type III. Phenolic insulations shall comply with ASTM C 795 and with the ASTM C 665 paragraph Corrosiveness. Supply the insulation with manufacturers recommended factor applied jacket.

2.5 Mineral Fiber

ASTM C 547

2.6 Aboveground Hot Pipeline

For aboveground hot pipeline above 60 degrees F insulation the following requirements shall be met. Supply the insulation with manufacturers recommended factory applied jacket.

2.6.1 Outdoor, Indoor - Exposed or Concealed

2.6.1.1 Mineral Fiber

ASTM C 547, Types I, II or III, supply the insulation with manufacturers recommended factory applied jacket.

2.6.1.2 Calcium Silicate

ASTM C 533, Type I indoor only, or outdoors above 250 degrees F pipe temperature.

2.6.1.3 Cellular Glass

ASTM C 552, Type II and Type III. Supply the insulation with manufacturers recommended factory applied jacket.

2.6.1.4 Flexible Cellular Insulation

ASTM C 534, Type I or II to 200 degrees F service.

2.6.1.5 Phenolic Insulation

ASTM C 1126 Type III to 250 F service shall comply with ASTM C 795. Supply the insulation with manufacturers recommended factory applied jacket.

2.6.1.6 Perlite Insulation

ASTM C 610

2.7 Above Ground Dual Temperature Pipeline - Outdoor, Indoor - Exposed or Concealed

Selection of insulation for use over a dual temperature pipeline system shall be in accordance with the most limiting/restrictive case. Find an allowable material from paragraph PIPE INSULATION MATERIALS and determine the required thickness from the most restrictive case. Use the thickness listed in paragraphs INSULATION THICKNESS for cold & hot pipe applications.

2.8 Below ground Pipeline Insulation

For below ground pipeline insulation the following requirements shall be met.

2.8.1 Cellular Glass

ASTM C 552, type II.

2.9 DUCT INSULATION MATERIALS

Duct insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.9.1 Rigid Mineral Fiber

ASTM C 612, Type IA, IB, II, III, & IV.

2.9.2 Flexible Mineral Fiber

ASTM C 553, Type I,or Type II up to 250 F. ASTM C 1290 Type III.

2.9.3 Cellular Glass

ASTM C 552, Type I.

2.9.4 Phenolic Foam

ASTM C 1126 Type II, shall comply with ASTM C 795.

2.9.5 Flexible Cellular

ASTM C 534 Type II.

2.10 EQUIPMENT INSULATION MATERIALS

Equipment insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.10.1 Cold Equipment Insulation

For temperatures below 60 degrees F.

2.10.1.1 Cellular Glass

ASTM C 552, Type I, Type III, or Type IV as required.

2.10.1.2 Flexible Cellular Insulation

ASTM C 534, Type II.

2.10.1.3 Phenolic Foam

ASTM C 1126 Type II shall comply with ASTM C 795.

2.10.2 Hot Equipment Insulation

For temperatures above 60 degrees F.

2.10.2.1 Rigid Mineral Fiber

ASTM C 612, Type IA, IB, II, III, IV, or V as required for temperature encountered to 1800 degrees F.

2.10.2.2 Flexible Mineral Fiber

ASTM C 553, Type I, II, III, IV, V, VI or VII as required for temperature encountered to 1200 degrees F.

2.10.2.3 Calcium Silicate

ASTM C 533, Type I, indoors only, or outdoors above 250 degrees F. Pipe shape may be used on diesel engine exhaust piping and mufflers to 1200 degrees F.

2.10.2.4 Cellular Glass

ASTM C 552, Type I, Type III, or Type IV as required.

2.10.2.5 Flexible Cellular Insulation

ASTM C 534, Type II, to 200 degrees F.

2.10.2.6 Phenolic Foam

ASTM C 1126 Type II to 250 degrees F shall comply with ASTM C 795.

2.10.2.7 Molded Expanded Perlite

ASTM C 610.

PART 3 EXECUTION

****

NOTE: Project specifications will contain only the specific pipe or duct systems and equipment in a particular project that require insulation. Lists are not inclusive of systems requiring insulation. Edit, modify, and add to the information contained in the lists as required.

****

3.1 APPLICATION - GENERAL

3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until [tests] [tests and heat tracing] specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds standard plates except where modified herein or on the drawings.

3.1.2 Firestopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in Section 07840 FIRESTOPPING.

3.1.3 Painting and Finishing

Painting shall be as specified in Section 09900 PAINTING, GENERAL.

3.1.4 Installation of Flexible Cellular Insulation

Flexible cellular insulation shall be installed with seams and joints sealed with a contact adhesive. Flexible cellular insulation shall not be used on surfaces greater than 200 degrees F. Seams shall be staggered when applying multiple layers of insulation. Insulation exposed to weather and not shown to have jacketing shall be protected with two coats of UV resistant finish as recommended by the manufacturer after the adhesive is dry.

3.1.5 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

3.1.6 Pipes/Ducts/Equipment which Require Insulation

Insulation is required, unless stated otherwise, on all pipes, ducts, or equipment, which operate at or below 60 F and at or above 80 F.

3.2 PIPE INSULATION INSTALLATION

3.2.1 Pipe Insulation

3.2.1.1 General

****

NOTE: Insulation may be omitted on heating piping in heated spaces, and on domestic cold water piping and interior roof drains where condensation and freezing are not problems and where hot piping is not hazardous to the occupants. However, the designer must maintain environmental control under heating and cooling conditions, meet the energy budget, not allow condensate formation and not allow freezing.

****

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

a. Pipe used solely for fire protection.

b. Chromium plated pipe to plumbing fixtures. However, fixtures for use by the physically handicapped shall have the hot water supply and drain, including the trap, insulated where exposed.

c. Sanitary drain lines.

d. Air chambers.

3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

****

NOTE: Exterior wall and roof penetration details will be shown on the drawings. See Section 15400 PLUMBING, GENERAL PURPOSE for additional information.

****

a. Pipe insulation shall be continuous through the sleeve.

b. An aluminum jacket with factory applied moisture retarder shall be provided over the insulation wherever penetrations require sealing.

c. Where penetrating interior walls, the aluminum jacket shall extend

2 inches beyond either side of the wall and shall be secured on each end with a band.

d. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.

e. Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 2 inchesabove the flashing with a band 1 inch from the end of the aluminum jacket.

f. Where penetrating exterior walls, the aluminum jacket required for pipe exposed to weather shall continue through the sleeve to a point 2 inches beyond the interior surface of the wall.

g. Where penetrating roofs, pipe shall be insulated as required for interior service to a point flush with the top of the flashing and sealed with vapor retarder coating. The insulation for exterior application shall butt tightly to the top of flashing and interior insulation. The exterior aluminum jacket shall extend 2 inches down beyond the end of the insulation to form a counter flashing. The flashing and counter flashing shall be sealed underneath with caulking.

h. For hot water pipes supplying lavatories or other similar heated service which requires insulation, the insulation shall be terminated on the backside of the finished wall. The insulation termination shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch applied with glass tape embedded between coats (if applicable). The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. Glass tape seams shall overlap 1 inch. Caulk the annular space between the pipe and wall penetration with approved fire stop material. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration at least 3/8 inch.

i. For domestic cold water pipes supplying lavatories or other similar cooling service which requires insulation, the insulation shall be terminated on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). The insulation shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch. The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. Caulk the annular space between the outer surface of the pipe insulation and the wall penetration with an approved fire stop material having vapor retarder properties. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration by at least 3/8 inch.

3.2.1.3 Pipes Passing Through Hangers

a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inchesand smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed.

b. Horizontal pipes larger than 2 inches at 60 degrees F and above shall be supported on hangers in accordance with MSS SP-69, and Section 15400 PLUMBING, GENERAL PURPOSE.

c. Horizontal pipes larger than 2 inches and below 60 degrees F shall be supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-69. An insulation insert of cellular glass or calcium silicate [or perlite (above (80 F))]shall be installed above each shield. The insert shall cover not less than the bottom 180 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert.

d. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360 degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe which are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.

e. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible cellular insulation shall conform to ASTM C 1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Cellular Pipe Insulation

Flexible cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less. Type II sheet insulation used on pipes larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, adhere insulation directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

3.2.1.5 Pipes in high abuse areas.

****

NOTE: In high abuse areas such as janitor closets and traffic areas in equipment rooms and kitchens, aluminum jackets will be shown. Normally, pipe insulation to the 6 foot level will be protected in high abuse areas. The areas will be specifically indicated by the designer.

****

In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, [welded PVC] [stainless steel] [aluminum] jackets shall be utilized. Pipe insulation to the 6 foot level shall be protected. [Other areas which specifically require protection to the 6 foot level are [_____].]

3.2.2 Aboveground Cold Pipelines

****

NOTE: Insulation may be omitted on domestic cold water piping and interior roof drains where condensation and freezing are not problems. However, the designer must maintain conditioned space control under cooling conditions - meet the energy budget, not allow condensation formation and not allow freezing.

****

The following cold pipelines shall be insulated per Table I minus 30 degrees to plus 60 degrees F:

a. [Domestic cold and chilled drinking water.]

b. Make-up water.

c. Horizontal and vertical portions of interior roof drains.

d. Refrigerant suction lines.

e. Chilled water.

f. Dual temperature water, i.e. HVAC hot/chilled water.

g. Air conditioner condensate drains.

h. Brine system cryogenics

i. Exposed lavatory drains, exposed domestic water piping and drains to areas for handicap personnel.

3.2.2.1   Insulation Thickness

****

NOTE: Table A is a reference to the ASHRAE 90.1 insulation standards. It is included as a reference should the designer want to introduce a different material, or utilize an existing material type for an application which is not listed, or is outside the temperature range listed in Table I. Table I may be modified for regions which meet one of the following conditions from TM 5-810-1. A wet bulb temperature of 19.4 degrees C (67 degrees F) or higher and the outside design relative humidity is 50 percent or higher (dew point temperature greater than 16 C (60 F)) for 3,000 hours or more. A wet bulb temperature of 22.8 degrees C (73 degrees F) or higher and the outside design relative humidity is 50 percent or higher (dew point temperature greater than 19 C (67 F)) for 1,500 hours or more. (Outside design relative humidity based on the 2.5 percent dry bulb and 5.0 percent wet bulb temperatures.) (Weather data obtained from TM 5-785.)

Tables I & II are not all inclusive of service insulation requirements. Edit, modify, and add to the tables as required for your project. Consideration may be given to increasing or decreasing the thickness of insulation required if, in the judgement of the designer, the situation warrants. For example, hot water piping in conditioned spaces may not require the tabulated thickness; or extremely cold systems in a high humidity climate may require additional insulation. In the case of cellular glass and phenolic foam, minimum thicknesses apply due to high breakage during shipment for smaller sizes. Further references for recommended thicknesses include the Standard Mechanical Code and manufacturers recommended thickness tables. The refrigerant suction piping thicknesses were determined for 35 degrees F service and the chilled water supply and return and dual temperature piping thicknesses were determined for 40 degrees F nominal service temperature. For materials with conductivities outside the range of conductivities given in Table A, adjustments to the given thicknesses may be made by use of this equation:

T = PR [(1 + t/PR)K/k -1]

where: PR = pipe outside radius; t = insulation thickness from Table A; K = conductivity of alternate material; k = lower value of conductivity

in Table A for the applicable fluid temperature range. (NOTE: The K/k term is the power for the parenthetical term).

Table A
Cooling Systems Pipe Diameter (Inches) **

Service or Range of Temperature (degrees F)	**Run-outs* up to 2 in**	**1 in & less**	**1.25 to 2 in**	**2.5 to 4 in**	**5 to 6 in**	**8 in & larger**
40 - 55	**0.5**	**0.5**	**0.75**	**1**	**1**	**1**
less than 40	**1**	**1**	**1.5**	**1.5**	**1.5**	**1.5**

Thicknesses are based on insulation having thermal conductivity in the range of 0.23 to 0.27 Btu in/(h sf degree F) when measured at 75 F.

*** When runouts to terminal units exceed 3.66 m, (12 feet,) the entire length of runout shall be insulated like the main feed pipe.**

**** The required minimum thicknesses do not consider water vapor transmission and condensation Additional insulation, vapor retarders, or both, may be required to limit water vapor transmission and condensation.**
****

Insulation thickness for cold pipelines shall be determined using Table I.

Table I - Cold Piping Insulation Thickness
Pipe Size (inches)

Type of Service	Material	Runouts up to 2 in*	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
[Brine System Cryogenics (-30 to 0 deg F)]	CG		2.5	2.5	3.0	3.0	3.5
	FC		1.5	1.5	1.5	1.75	1.75
	PF		1.0	1.0	1.5	1.5	1.5
[Brine System Cryogenics 0 to 34 deg F)]	CG		2.0	2.0	2.0	2.5	3.0
	FC		1.0	1.0	1.25	1.25	1.5
	PF		1.0	1.0	1.0	1.0	1.5
[Refrigerant suction piping	CG		1.5	1.5	1.5	1.5	1.5
	FC		1.0	1.0	1.0	1.0	1.0
	PF		1.0	1.0	1.0	1.0	1.0]
[Chilled water supply & return & dual temp piping]	CG	1.5	1.5	1.5	2.0	2.0	2.0
	FC	0.5	1.0	1.0	1.0	1.0	1.0
	PF	1.0	1.0	1.0	1.0	1.0	1.0
[Cold domestic water, above	CG	1.5	1.5	1.5	1.5	1.5	1.5
	FC	3/8	3/8	3/8	3/8	3/8	3/8

Table I - Cold Piping Insulation Thickness
Pipe Size (inches)

Type of Service	Material	Runouts up to 2 in*	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
and below ceilings & makeup water]	PF	1.0	1.0	1.0	1.0	1.0	1.0
[Exposed lavatory drains exposed domestic water piping & drains to areas for handicap personnel]	FC	0.5	0.5	0.5	0.5	3/4	3/4
	MF	0.5	1.0	1.0	1.5	1.5	1.5
[Horizontal & vertical roof drain leaders (including underside of roof drain fitting)]	FC		0.5	0.5	0.5	0.5	0.5
	PF		1.0	1.0	1.0	1.0	1.0
	CG		1.5	1.5	1.5	1.5	1.5
[Air conditioning condensate drain located inside building]	FC		3/8	0.5	0.5	N/A	N/A
	PF		1.0	1.0	1.0	N/A	N/A

*When runouts to terminal units exceed 12 feet, the entire length of runout shall be insulated like main feed pipe.

LEGEND:

PF - Phenolic Foam
CG - Cellular Glass
CS - Calcium Silicate
MF - Mineral Fiber
FC - Flexible Cellular

3.2.2.2 Jacket for Mineral Fiber, Cellular Glass, and Phenolic Foam Insulated Pipe

****

NOTE: In high abuse areas such as janitor closets and traffic areas in equipment rooms and kitchens, aluminum jackets will be shown. Normally, pipe insulation to the 1.8 m (6 foot) level will be protected in high abuse areas. The areas will be specifically indicated by the designer.

****

Insulation shall be covered with a factory applied vapor retarder jacket or field applied seal welded PVC jacket. Insulation inside the building shown to be protected with an aluminum jacket shall have the insulation and vapor retarder jacket installed as specified herein. The aluminum jacket shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum jackets shall be utilized. Pipe insulation to the 6 ft level will be protected. Other areas which specifically require protection to the 6 ft level are [_____].

3.2.2.3 Insulation for Straight Runs (Mineral Fiber, Cellular Glass and Phenolic Foam)

a. Insulation shall be applied to the pipe with joints tightly butted. Insulation shall have all joints and ends sealed with vapor retarder coating.

b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches. Butt strips 3 inches wide shall be provided for circumferential joints.

c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. If staples are used, they shall be sealed per paragraph 3.2.2.3 e.

d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F during installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.

e. All Staples, including those used to repair factory self-seal lap systems, shall be coated with a vapor retarder coating. All seams, except those on factory self-seal systems shall be coated with vapor retarder coating.

f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating with vapor retarder coating. The patch shall extend not less than 1-1/2 inches past the break.

g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with vapor retarder coating.

3.2.2.4 Insulation for Fittings and Accessories

a. Pipe insulation shall be terminated 6 inches from each flange, union, valve, anchor, or fitting in all directions. The ends of the insulation shall be coated with vapor retarder coating.

b. Precut, preformed insulation for placement over fittings, flanges, unions, valves, anchors, and mechanical couplings shall conform to MICA plates: 5 for anchors; 10, 11, 12, & 13 for fittings; 14, 15, & 16 for valves; 17 for flanges and unions; and 18 for couplings. Precut, preformed insulation shall exhibit the same properties as the adjoining pipe insulation. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Loose fill mineral fiber or insulating cement shall be used to fill the voids. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow'.

c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Tape seams shall overlap 1 inch.The coating shall extend out onto the adjoining pipe insulation 2 inches.

d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.

e. Flexible connections at pumps and other equipment shall be insulated with 0.5 inch flexible cellular insulation, unless otherwise indicated.

f. Insulation shall be marked showing the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same thickness as adjoining pipe insulation and the insulation shall be protected with one coat of vapor retarder coating under the PVC cover. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

3.2.3 Aboveground Hot Pipelines

The following hot pipelines above 60 degrees F shall be insulated per Table II:

a. Domestic hot water supply & recirculating system.

b. Steam.

c. Condensate & compressed air discharge.

d. Hot water heating.

e. Heated oil.

f. Water defrost lines in refrigerated rooms.

3.2.3.1 Insulation Thickness

****

NOTE: For materials with conductivities outside the range of the listed conductivities given in Table B, adjustments may be made to the listed thicknesses by use of the equation given below.

T = PR (1 + t/PR)K/k -1

where: PR = pipe outside radius; t = insulation thickness from Table A; K = conductivity of alternate material; k = lower value of conductivity in the table for the applicable fluid temperature range. (NOTE: The K/k term is the power for the parenthetical term).

Table II is not all inclusive of service insulation requirements. Edit, modify, and add to the table as required for your project. Consideration may be given to increasing or decreasing the thickness of insulation required if, in the judgement of the designer, the situation warrants. In the case of cellular glass and phenolic foam, minimum thicknesses apply due to high breakage during shipment for smaller sizes.

Table B
Thickness of Pipe Insulation for Pipes Handling Steam and Fluids Other Than Domestic Hot Water (inches)

	Insulation Conductivity		Nominal Pipe Diameter (in)				
Fluid Temperature Range (F)	Conductivity Range Btu in/ (h sf F)	Mean Rating Temperature F	Runouts* up to 2	1 & less	1.25 to 2	2.55 to 4	8 & to 6 lgr
above 350	0.32 - 0.34	250	1.5	2.5	2.5	3.0	3.5	3.5
251 - 350	0.29 - 0.31	200	1.5	2.0	2.5	2.5	3.5	3.5
201 - 250	0.27 - 0.30	150	1.0	1.5	1.5	2.0	2.0	3.5
141 - 200	0.25 - 0.29	125	0.5	1.5	1.5	1.5	1.5	1.5
105 - 140	0.24 - 0.28	100	0.5	1.0	1.0	1.0	1.5	1.5
Domestic and Service Hot Water Systems**								
> 105	0.24 - 0.28	100	0.5	1.0	1.0	1.5	1.5	1.5

*** When runouts to terminal units exceed 12 ft, the entire length of**

Table B

Thickness of Pipe Insulation for Pipes Handling Steam and Fluids Other Than Domestic Hot Water (inches)

	Insulation Conductivity		Nominal Pipe Diameter (in)				
Fluid Temperature Range (F)	**Conductivity Range Btu in/ (h sf F)**	**Mean Rating Temperature F**	**Runouts* up to 2 less**	**1 & to 2**	**1.25 to 4**	**2.55 to 6**	**8 & lgr**

runout shall be insulated like the main feed pipe.

**** Applies to recirculating sections of service or domestic hot water systems and first 8 feet from storage tank for non-recirculating systems.**

****

Insulation thickness for hot pipelines shall be determined using Table II.

LEGEND:

PF - Phenolic Foam
CG - Cellular Glass
CS - Calcium Silicate
MF - Mineral Fiber
FC - Flexible Cellular
PL - Perlite

Table II - Hot Piping Insulation Thickness
Pipe Size (inches)

Type of Service (degrees F)	Material	Runouts up to 2 in *	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
[Hot domestic water supply & recirculating system, & water defrost lines (200 F max)**]	CG		1.5	1.5	1.5	1.5	1.5
	FC		0.5	1.0	1.0	1.5	1.5
	PF		0.5	1.0	1.0	1.0	1.0
	MF		0.5	1.5	1.5	1.5	1.5
[Compressed Air discharge steam & condensate return (201-250 F)]	CG		1.5	2.0	2.0	2.0	3.5
	PF		1.0	1.0	1.0	1.0	1.5
	MF		1.5	1.5	2.0	2.0	2.5
	CS/PL		1.5	2.0	2.5	2.5	3.5
[Heating hot water, supply & return, & Heating oil (250 F max	CG	1.5	1.5	2.0	2.0	2.5	3.0
	PF	0.5	1.0	1.0	1.0	1.0	1.5
	MF	0.5	1.5	1.5	2.0	2.5	3.0
	CS	1.0	1.5	2.0	2.5	2.5	3.0]

Table II - Hot Piping Insulation Thickness
Pipe Size (inches)

Type of Service (degrees F)	Material	Runouts up to 2 in *	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
[Medium Temp Hot water & stream, & heated oil (251 - 350F)	CG	1.5	2.5	3.0	3.5	3.5	4.0
	MF	1.5	2.0	2.5	2.5	3.0	3.5
	CS/PL	1.5	2.5	2.5	3.5	3.5	4.5]
[High Temp Hot water & steam (351 - 500 F)	CG	2.0	3.5	4.0	4.5	5.0	5.5
	MF	1.5	3.0	3.5	4.0	4.0	4.5
	CS/PL	2.0	3.5	4.0	4.5	5.0	5.5]

* When runouts to terminal units exceed 12 feet, the entire length of runout shall be insulated like the main feed pipe.

** Applies to recirculating sections of service or domestic hot water systems and first 8 feet from storage tank for non-recirculating systems.

3.2.3.2 Jacket for Insulated Hot Pipe

Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type II jacket or field applied aluminum where required or seal welded PVC.

3.2.3.3 Insulation for Straight Runs

a. Insulation shall be applied to the pipe with joints tightly butted.

b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches, and butt strips 3 inches wide shall be provided for circumferential joints.

c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. Adhesive may be omitted where pipe is concealed.

d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F and shall be installed in accordance with manufacturer's instructions. Laps and butt strips shall be stapled whenever there is nonadhesion of the system. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.

e. Breaks and punctures in the jacket material shall be patched by either wrapping a strip of jacket material around the pipe and securing with adhesive and staple on 4 inch centers (if not factory self-sealing), or patching with tape and sealing with a brush coat of vapor retarder coating. Adhesive may be omitted where pipe is concealed. Patch shall extend not less than 1-1/2 inches past the break.

f. Flexible cellular pipe insulation shall be installed by slitting tubular sections and applying onto piping or tubing. Alternately, whenever possible, slide unslit sections over the open ends of piping or tubing. All seams and butt joints shall be secured and sealed with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Insulation shall be pushed on the pipe, never pulled. Stretching of insulation may result in open seams and joints. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives shall be used. Type II sheet insulation when used on pipe larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

3.2.3.4 Insulation for Fittings and Accessories

a. The run of the line pipe insulation shall have the ends brought up to the item.

b. Insulation of the same thickness and conductivity as the adjoining pipe insulation, either premolded or segmented, shall be placed around the item abutting the adjoining pipe insulation, or if nesting size insulation is used, overlapping 2 inches or one pipe diameter. Loose fill mineral fiber or insulating cement shall be used to fill the voids. Insulation for elbows less than 3 inch size shall be premolded. Insulation for elbows 3 inch size and larger shall be either premolded or segmented. Elbows insulated using segments shall have not less than 3 segments per elbow. Insulation may be wired or taped on until finish is applied.

c. Upon completion of installation of insulation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of adhesive applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. Adhesive shall extend onto the adjoining insulation not less than 2 inches. The total dry film thickness shall be not less than 1/16 inch.

d. Insulation terminations shall be tapered to unions at a 45-degree angle.

e. At the option of the Contractor, factory premolded one- or two-piece PVC fitting covers may be used in lieu of the adhesive and embedded glass tape. Factory premolded segments or factory or field cut blanket insert insulation segments shall be used under the cover and shall be the same thickness as adjoining pipe insulation. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers.

3.2.4 Piping Exposed to Weather

Piping exposed to weather shall be insulated and jacketed as specified for the applicable service inside the building. After this procedure, an aluminum jacket or PVC jacket shall be applied. PVC jacketing requires no factory applied jacket beneath it, however an all service jacket shall be applied if factory applied jacketing is not furnished. Flexible cellular insulation exposed to weather shall be treated in accordance with paragraph INSTALLATION OF FLEXIBLE CELLULAR INSULATION.

3.2.4.1 Aluminum Jacket

The jacket for hot piping may be factory applied. The jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12 inch centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping 60 degrees F and below shall be sealed with caulking while overlapping to prevent moisture penetration. Where jacketing on piping 60 degrees F and below abuts an uninsulated surface, joints shall be caulked to prevent moisture penetration. Joints on piping above 60 degrees F shall be sealed with a moisture retarder.

3.2.4.2 Insulation for Fittings

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting covers shall be used with PVC lagging and adhesive welded weather tight.

3.2.4.3 PVC Lagging

PVC lagging shall be ultraviolet resistant and adhesive welded weather tight with manufacturer's recommended adhesive. Installation shall include provision for thermal expansion.

3.2.5 Below ground Pipe Insulation

****

NOTE: Where significant amounts (approximately 25 feet) of below grade piping is to be insulated, a separate specification section will be developed to allow factory preinsulated systems as an alternate to field applied systems. Portions of the underground piping that are to be insulated using this paragraph will be indicated on the drawings.

****

The following shall be included:

a. Heated oil.

b. Domestic hot water.

c. Heating hot water.

d. Dual temperature water.

e. Steam.

f. Condensate.

3.2.5.1 Type of Insulation

Below ground pipe shall be insulated with 3 inch cellular glass insulation set in a coat of bedding compound as recommended by the manufacturer.

3.2.5.2 Installation of Below ground Pipe Insulation

a. Bore surfaces of the insulation shall be coated with a thin coat of gypsum cement of a type recommended by the insulation manufacturer. Coating thickness shall be sufficient to fill surface cells of insulation. Mastic type materials shall not be used for this coating.

b. Stainless steel bands, 3/4 inch wide by 0.020 inch thick shall be used to secure insulation in place. A minimum of two bands per section of insulation shall be applied. As an alternate, fiberglass reinforced tape may be used to secure insulation on piping up to 12 inches in diameter. A minimum of two bands per section of insulation shall be applied.

c. Insulation shall terminate at anchor blocks but shall be continuous through sleeves and manholes.

d. At point of entry to buildings, underground insulation shall be terminated 2 inches inside the wall or floor, shall butt tightly against the aboveground insulation and the butt joint shall be sealed with high temperature silicone sealant.

e. Provision for expansion and contraction shall be made in accordance with the insulation manufacturer's recommendations.

f. Flanges, couplings, valves, and fittings shall be insulated with factory premolded, prefabricated, or field-fabricated sections of insulation of the same material and thickness as the adjoining pipe insulation. Insulation sections shall be secured in place with wire, bore surfaces coated, and joints sealed as specified.

g. Insulation, including fittings, shall be finished with three coats of asphaltic mastic, with 6 by 5.5 mesh synthetic reinforcing fabric embedded between coats. Fabric shall be overlapped a minimum of 2 inches at joints. Total film thickness shall be a minimum of 3/16 inch. As an alternate, a prefabricated bituminous laminated jacket, reinforced with internal reinforcement mesh, shall be applied to the insulation. Jacketing material and application procedures shall match manufacturer's written instructions.

h. At termination points, other than building entrances, the mastic and cloth or tape shall cover the ends of insulation and extend 2 inches along the bare pipe.

3.3 DUCT INSULATION INSTALLATION

****

NOTE: Insulation may be omitted on heating duct in heated spaces. Designer will determine if internally lined ducts are comparable in insulating value to those unlined ducts to be insulated. If

not, field insulation will be added.

The designer must maintain conditioned space control under cooling and heating conditions - meet the energy budget, and not allow condensation formation. The following do not require insulation: factory fabricated double wall internally insulated duct, glass fiber duct, site-erected air conditioning casings and plenums constructed of factory-insulated sheet metal panels, ducts internally lined with insulation or sound absorbing material, unless indicated otherwise, return ducts in ceiling spaces or as indicated, supply ducts in ceiling spaces which are used as return air plenums (or as indicated), factory preinsulated flexible ducts, ducts within HVAC equipment, exhaust air ducts unless noted, and duct portions inside walls or floor-ceiling space in which both sides of the space are exposed to conditioned air and the space is not vented or exposed to unconditioned air.

Ceiling spaces shall be defined as those spaces between the ceiling and bottom of floor deck or roof deck inside the air conditioned space insulated envelope, and ceilings which form plenums.
****

Except for oven hood exhaust duct insulation, corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. [Duct insulation shall be omitted on exposed supply and return ducts in air conditioned spaces [where the difference between supply air temperature and room air temperature is less than 15 degrees F] unless otherwise shown.] Air conditioned spaces shall be defined as those spaces directly supplied with cooled conditioned air (or provided with a cooling device such as a fan-coil unit) and heated conditioned air (or provided with a heating device such as a unit heater, radiator or convector).

3.3.1 Duct Insulation Thickness

****
NOTE: The following tables are adapted from ASHRAE standard 90.1. They may be used to modify the thicknesses listed in Table III. The thicknesses listed are recommended, and may be changed at the discretion of the designer Limit thickness of flexible cellular insulation to 25 mm (1 inch) due to flame spread and smoke development rating.

Minimum Duct Insulation (inches)

	Cooling		Heating	
Duct Location	**Annual Cooling Degree Days Base 65 F**	**Insulation R-Value (h sf F)/Btu**	**Annual Heating Degree Days Base 65 F**	**Insulation R-Value (h sf F)/Btu**

Minimum Duct Insulation (inches)

	Cooling		**Heating**	
Exterior Of Building	**<500 -**	**3.3**	**<1500**	**3.3**
	500 - 1150	**5.0**	**1500 - 4500**	**5.0**
	1151 - 2000	**6.5**	**4501 - 7500**	**6.5**
	>2000	**8.0**	**>7500**	**8.0**
	Temperature Difference	**Insulation R-Value (h sf F)/Btu**	**Temperature Difference**	**Insulation R-Value (h sf F)/Btu**
Inside building envelope or in un-conditioned spaces	**<15**	**None reqd**	**<15**	**None reqd**
	15<TD<40	**3.3**	**15<TD<40**	**3.3**
	40<TD	**5.0**	**40<TD**	**5.0**

These R values do not include the film resistances. The required minimum thicknesses do not consider water vapor transmission and condensation. Additional insulation, vapor retarders, or both, may be required to limit vapor transmission and condensation. Where ducts are designed to convey both heated and cooled air, duct insulation shall be as required by the most restrictive condition. Where exterior walls are used as plenum walls, wall insulation shall be as required by the most restrictive condition of this section or the insulation for the building envelope. Cooling ducts are those designed to convey mechanically cooled air or return ducts in such systems. Heating ducts are those designed to convey mechanically heated air or return ducts in such systems. Thermal Resistance is to be measured in accordance with ASTM C 518 at a mean temperature of 75 degrees F. The temperature difference is at design conditions between the space within which the duct is located and the design air temperature in the duct. Resistance for runouts to terminal devices less than 10 ft in length need not exceed 3.3 (h sf F)/Btu. Unconditioned spaces include crawlspaces and attics.
****

Duct insulation thickness shall be in accordance with Table III.

Maximum thickness for flexible cellular insulation shall not exceed 25 mm, to comply with ASTM E 84 flame spread/smoke developed ratings of 25/50

Table III - Minimum Duct Insulation (inches)

Cold Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5
Warm Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5

Table III - Minimum Duct Insulation (inches)

Maximum thickness for flexible cellular insulation shall not exceed 1 inch to comply with ASTM E 84 flame spread/smoke developed ratings of 25/50.

3.3.2 Insulation and Vapor Retarder for Cold Air Duct

****

NOTE: Mixing boxes, relief air ducts, and filter boxes should not be insulated unless condensation is a problem. Insulation may be omitted on that portion of return air ducts installed in the ceiling spaces where condensation is not a problem, and on that portion of supply ducts installed in ceiling spaces used as a return air plenum where condensation is not a problem. If condensation is a problem or insulation is required for unique building design, delete brackets and indicate on the drawings the locations the insulation is to be installed. For ducts to be used for both heating and cooling, the requirements for cold ducts will govern.

****

Insulation and vapor retarder for cold air duct below 60 degrees F, ducts and associated equipment shall be insulated to a thickness which is in accordance with Table III. The following shall be insulated:

a. [Supply ducts.]

b. [Return air ducts.]

c. [Relief ducts.]

d. [Flexible runouts (field-insulated).]

e. [Plenums.]

f. [Duct-mounted coil casings.]

g. [Coil headers and return bends.]

h. [Coil casings.]

i. [Fresh air intake ducts.]

j. [Filter boxes.]

k. [Mixing boxes (field-insulated).]

l. [Supply fans (field-insulated).]

m. [Site-erected air conditioner casings.]

n. [Ducts exposed to weather.]

o. [Combustion air intake ducts.]

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf and rigid type where exposed, minimum density 3 pcf. Insulation for round/oval ducts shall be flexible type, minimum density 3/4 pcf with a factory Type I or II jacket; or, a semi rigid board, minimum density 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered, with a factory applied Type I or II all service jacket. Insulation for exposed ducts shall be provided with either a white, paintable, factory-applied Type I jacket or a vapor retarder jacket coating finish as specified. Insulation on concealed duct shall be provided with a factory-applied Type I or II vapor retarder jacket. The total dry film thickness shall be approximately 1/16 inch. Duct insulation shall be continuous through sleeves and prepared openings except fire wall penetrations. Duct insulation terminating at fire dampers, shall be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Duct insulation and vapor retarder shall cover the collar, neck, and any uninsulated surfaces of diffusers, registers and grills. Vapor retarder materials shall be applied to form a complete unbroken vapor seal over the insulation. Sheet Metal Duct shall be sealed in accordance with CEGS 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

3.3.2.1 Installation on Concealed Duct

a. For rectangular, oval or round ducts, insulation shall be attached in accordance with MICA installation procedures.

b. For rectangular and oval ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

d. Insulation shall be impaled on the mechanical fasteners (self stick pins) where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.

e. Self-locking washers shall be installed where mechanical fasteners are used. The pin shall be trimmed back and bent over.

f. Jacket overlaps shall be secured with staples and tape as necessary to ensure a secure seal. Staples, tape and seams shall be coated with a brush coat of vapor retarder coating.

g. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder jacket. The patches shall extend not less than 2 inches beyond the break or penetration in all directions and shall be secured with tape and staples. Staples and tape joints shall be sealed with a brush coat of vapor retarder coating.

h. At jacket penetrations such as hangers, thermometers, and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating.

i. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish or tape with a brush coat of vapor retarder coating.. The coating shall overlap the adjoining insulation and uninsulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

j. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

3.3.2.2 Installation on Exposed Duct Work

a. For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches.

b. Duct insulation shall be formed with minimum jacket seams. Each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over.

c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and the pin trimmed or bent over.

d. Joints in the insulation jacket shall be sealed with a 4 inchwide strip of tape. Tape seams shall be sealed with a brush coat of vapor retarder coating.

e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with tape and stapled. Staples and joints shall be sealed with a brush coat of vapor retarder coating.

f. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a brush coat of vapor retarder coating.

g. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The coating shall overlap the adjoining insulation and uninsulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

h. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation with minimum density of 3/4 pcf, attached as per MICA standards.

3.3.3 Insulation for Warm Air Duct

****

NOTE: Mixing boxes, relief air ducts, and filter boxes should not be insulated unless condensation is a problem. Factory fabricated double-walled internally insulated duct exposed to the weather should be externally insulated on long runs of duct in cold climates. If insulation is required for unique building design, indicate on the drawings the locations the insulation is to be installed. Ducts for dual purposes will be as required for cold duct.

****

For warm air ducts above 60 degrees F, ducts and associated equipment shall be insulated to a thickness which is in accordance with Table III. The following shall be insulated:

a. [Supply ducts.]

b. [Return air ducts.]

c. [Relief air ducts.]

d. [Flexible runouts (field insulated).]

e. [Plenums.]

f. [Duct-mounted coil casings.]

g. [Coil-headers and return bends.]

h. [Coil casings.]

i. [Fresh air intake ducts.]

j. [Filter boxes.]

k. [Mixing boxes.]

l. [Supply fans.]

m. [Site-erected air conditioner casings.]

n. [Ducts exposed to weather.]

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf; and rigid type where exposed, minimum density 3 pcf. Insulation on exposed ducts shall be provided with a white, paintable, factory-applied Type II jacket, or finished with adhesive finish. Flexible type insulation shall be used for round ducts, minimum density 3/4 pcf with a factory-applied Type II jacket. Insulation on concealed duct shall be provided with a factory-applied Type II jacket.

Adhesive finish where indicated to be used shall be accomplished by applying two coats of adhesive with a layer of glass cloth embedded between the coats. The total dry film thickness shall be approximately 1/16 inch. Duct insulation shall be continuous through sleeves and prepared openings. Duct insulation shall terminate at fire dampers and flexible connections.

3.3.3.1 Installation on Concealed Duct

a. For rectangular, oval and round ducts, insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts 24 inches and larger, insulation shall be secured to the bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corner.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corners.

d. The insulation shall be impaled on the mechanical fasteners where used. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type hangers.

e. Self-locking washers shall be installed where mechanical fasteners are used and the pin trimmed and bent over.

f. Insulation jacket shall overlap not less than 2 inches at joints and the lap shall be secured and stapled on 4 inch centers.

3.3.3.2 Installation on Exposed Duct

a. For rectangular ducts, the rigid insulation shall be secured to the duct by the use of mechanical fasteners on all four sides of the duct, spaced not more than 16 inches apart and not more than 6 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger and a minimum of one row for each side of duct less than 12 inches.

b. Duct insulation with factory-applied jacket shall be formed with minimum jacket seams, and each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projection is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over the projection. Jacket shall be continuous across seams, reinforcing, and projections. Where the height of projections is greater than the insulation thickness, insulation and jacket shall be carried over the projection.

c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and pin excess clipped and bent over.

d. Joints on jacketed insulation shall be sealed with a 4 inch wide strip of tape and brushed with vapor retarder coating.

e. Breaks and penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with adhesive and stapled.

f. Insulation terminations and pin punctures shall be sealed with tape and brushed with vapor retarder coating.

g. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation, minimum density of 3/4 pcf attached by staples spaced not more than 16 inches and not more than 6 inches from the degrees of joints. Joints shall be sealed in accordance with paragraph 3.3.3.2 d.

3.3.4 Ducts Handling Air for Dual Purpose

For air handling ducts for dual purpose below and above 60 degrees F, ducts shall be insulated as specified for cold air duct.

3.3.5 Insulation for Evaporative Cooling Duct

Evaporative cooling supply duct located in spaces not evaporatively cooled, shall be insulated. Material and installation requirements shall be as specified for duct insulation for warm air duct.

3.3.6 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

3.3.7 Duct Exposed to Weather

3.3.7.1 Installation

Ducts exposed to weather shall be insulated and finished as specified for the applicable service for exposed duct inside the building. After the above is accomplished, the insulation shall then be further finished as detailed in the following subparagraphs.

3.3.7.2 Round Duct

Aluminum jacket with factory applied moisture retarder shall be applied with the joints lapped not less than 3 inches and secured with bands located at circumferential laps and at not more than 12 inch intervals throughout. Horizontal joints shall lap down to shed water and located at 4 or 8 o'clock position. Joints shall be sealed with caulking to prevent moisture penetration. Where jacketing abuts an uninsulated surface, joints shall be sealed with caulking.

3.3.7.3 Fittings

Fittings and other irregular shapes shall be finished as specified for rectangular ducts.

3.3.7.4 Rectangular Ducts

Two coats of weather barrier mastic reinforced with fabric or mesh for outdoor application shall be applied to the entire surface. Each coat of weatherproof mastic shall be 1/16 inch minimum thickness. The exterior shall be a metal jacketing applied for mechanical abuse and weather protection, and secured with screws.

3.4 EQUIPMENT INSULATION INSTALLATION

3.4.1 General

Removable insulation sections shall be provided to cover parts of equipment which must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

a. Handholes.

b. Boiler manholes.

c. Cleanouts.

d. ASME stamps.

e. Manufacturer's nameplates.

3.4.2 Insulation for Cold Equipment

****

NOTE: Special cold equipment including Government-furnished equipment that requires field-applied insulation will be inserted in the appropriate paragraph.

****

Cold equipment below 60 degrees F: Insulation shall be furnished on equipment handling media below 60 degrees F including the following:

a. Pumps.

b. Refrigeration equipment parts that are not factory insulated.

c. Drip pans under chilled equipment.

d. Cold water storage tanks.

e. Water softeners.

f. Duct mounted coils.

g. Cold and chilled water pumps.

h. Pneumatic water tanks.

i. Roof drain bodies.

j. Air handling equipment parts that are not factory insulated.

k. Expansion and air separation tanks.

3.4.2.1 Insulation Type

Insulation shall be suitable for the temperature encountered. Thicknesses shall be as follows:

a. Equipment handling media between 35 and 60 degrees F: 1.5 inch thick cellular glass, 1 inch thick flexible cellular, or 1 inch thick phenolic foam.

b. Equipment handling media between 0 degree F and 34 degrees F: 3 inch thick cellular glass, 1 1/2 inch flexible cellular, or 1 1/12 inch thick phenolic foam.

c. Equipment handling media between minus 30 degrees F and 1 degree F: 3 1/2 inch thick cellular glass 1 3/4 inch thick flexible cellular, or 1 1/2 inch thick phenolic foam.

3.4.2.2 Pump Insulation

a. Pumps shall be insulated by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints which do not leave raw ends of insulation exposed. Joints between sides and between sides and bottom shall be joined by adhesive with lap strips for rigid mineral fiber and contact adhesive for flexible cellular insulation. The box shall conform to the requirements of MICA Insulation Stds plate No. 49 when using flexible cellular insulation. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.

b. Exposed insulation corners shall be protected with corner angles.

c. Upon completion of installation of the insulation, including removable sections, two coats of vapor retarder coating shall be applied with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Caulking shall be applied to parting line, between equipment and removable section insulation, and at all penetrations.

3.4.2.3 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12 inch centers except flexible cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. Cellular glass and phenolic foam insulation shall be set in a coating of bedding compound, and joints shall be sealed with bedding compound as recommended by the manufacturer.

d. Insulation on heads of heat exchangers shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint. The entire surface of the removable section shall be finished by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch.

e. Exposed insulation corners shall be protected with corner angles.

f. Insulation on equipment with ribs shall be applied over 6 x 6 inches by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 x 2 incheswashers or shall be securely banded or wired in place on 12 inch centers.

3.4.2.4 Vapor Retarder

Upon completion of installation of insulation, penetrations shall be caulked. Two coats of vapor retarder coating shall be applied over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

3.4.3 Insulation for Hot Equipment

****

NOTE: Special hot equipment such as sterilizers, expansion tanks for high temperature water systems, process equipment, and special Government-furnished equipment that requires field-applied insulation will be inserted in the appropriate subparagraphs. Expansion tanks on hot water heating systems will not normally be insulated.

****

Insulation shall be furnished on equipment handling media above 60 degrees F including the following:

a. Converters.

b. Heat exchangers.

c. Hot water generators.

d. Water heaters.

e. Pumps handling media above 130 degrees F.

f. Fuel oil heaters.

g. Hot water storage tanks.

h. Air separation tanks.

i. Surge tanks.

j. Flash tanks.

k. Feedwater heaters.

l. Unjacketed boilers or parts of boilers.

m. Boiler flue gas connection from boiler to stack (if inside).

n. Induced draft fans.

o. Fly ash and soot collectors.

p. Condensate receivers.

3.4.3.1 Insulation

****

NOTE: Additional data on insulation thickness may be found in manufacturers catalogs and computer sizing programs and from individual calculations. Care should be taken in the selection of an insulating material for high temperature equipment. If the equipment rises to high operating temperature in a short period of time, thermal stresses may occur in rigid insulations which may lead to cracking and subsequent deterioration of the insulation.

****

Insulation shall be suitable for the temperature encountered. Shell and tube-type heat exchangers shall be insulated for the temperature of the shell medium.

Insulation thickness for hot equipment shall be determined using Table IV:

Legend

RMF: Rigid Mineral Fiber
FMF: Flexible Mineral Fiber
CS: Calcium Silicate
PL: Perlite
CG: Cellular Glass
FC: Flexible Cellular
PF: Phenolic Foam

TABLE IV
Insulation Thickness for Hot Equipment (mm)

Equipment handling steam or other media to indicated pressure or temperature limit	Material	Thickness
103.4 kPa	RMF	50 mm
or	FMF	50 mm

121 C	CS/PL	100 mm
	CG	75 mm
	PF	40 mm
	FC(<93 C)	25 mm
1379.0kPa or 204 C	RMF	75 mm
	FMF	75 mm
	CS/PL	100 mm
	CG	100 mm
316 C	RMF	125 mm
	FMF	150 mm
	CS/PL	150 mm
	CG	150 mm

316 C: Thickness necessary to limit the external temperature of the insulation to 50 C, except that diesel engine exhaust piping nd mufflers shall be covered with 150 mm thick material suitable for 650 degrees C service. Heat transfer calculations shall be submitted to substantiate insulation and thickness selection.

TABLE IV
Insulation Thickness for Hot Equipment (Inches)

Equipment handling steam or media to indicated pressure or temperature limit:	Material	Thickness
15 psig or 250F	RMF	2.0 inches
	FMF	2.0 inches
	CS/PL	4.0 inches
	CG	3.0 inches
	PF	1.5 inches
	FC (<200F)	1.0 inches
200 psig or 400 F	RMF	3.0 inches
	FMF	3.0 inches
	CS/PL	4.0 inches
	CG	4.0 inches
600 F	RMF	5.0 inches
	FMF	6.0 inches
	CS/PL	6.0 inches
	CG	6.0 inches

>600 F: Thickness necessary to limit the external temperature of the insulation to 120F, except that diesel engine exhaust piping and mufflers shall be covered with 6.0 inch thick material suitable for 1200 degrees F service. Heat transfer calculations shall be submitted to substantiate insulation and thickness selection.

3.4.3.2 Insulation of Pumps

Pumps shall be insulated by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints which do not leave raw ends of insulation exposed. Bottom and sides shall be banded to form a rigid housing which does not rest on the pump. Joints between top cover and sides shall fit tightly. The top cover shall have a joint forming a female shiplap joint on the side pieces and a male joint on the top cover, making the top cover removable. Two coats of Class I adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line of the removable sections and penetrations.

3.4.3.3 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not greater than 12 inch centers except flexible cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. On high vibration equipment, cellular glass insulation shall be set in a coating of bedding compound as recommended by the manufacturer, and joints shall be sealed with bedding compound. Mineral fiber joints shall be filled with finishing cement.

d. Insulation on heads of heat exchangers shall be removable. The removable section joint shall be fabricated using a male-female shiplap type joint. Entire surface of the removable section shall be finished as specified.

e. Exposed insulation corners shall be protected with corner angles.

f. On equipment with ribs, such as boiler flue gas connection, draft fans, and fly ash or soot collectors, insulation shall be applied over 6 x 6 inch by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 x 2 inch washers or shall be securely banded or wired in place on 12 inch (maximum) centers.

g. On equipment handling media above 600 degrees F, insulation shall be applied in two or more layers with joints staggered.

h. Upon completion of installation of insulation, penetrations shall be caulked. Two coats of adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

3.4.4 Equipment Handling Dual Temperature Media

Below and above 60 degrees F: equipment handling dual temperature media shall be insulated as specified for cold equipment.

3.4.5 Equipment Exposed to Weather

3.4.5.1 Installation

Equipment exposed to weather shall be insulated and finished in accordance with the requirements for ducts exposed to weather in paragraph DUCT INSULATION INSTALLATION.

3.4.5.2 Optional Panels

At the option of the Contractor, prefabricated metal insulation panels may be used in lieu of the insulation and finish previously specified. Thermal performance shall be equal to or better than that specified for field applied insulation. Panels shall be the standard catalog product of a manufacturer of metal insulation panels. Fastenings, flashing, and support system shall conform to published recommendations of the manufacturer for weatherproof installation and shall prevent moisture from entering the insulation. Panels shall be designed to accommodate thermal expansion and to support a 250 pound walking load without permanent deformation or permanent damage to the insulation. Exterior metal cover sheet shall be aluminum and exposed fastenings shall be stainless steel or aluminum.

-- End of Section --

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DEPARTMENT OF THE NAVY                     NFGS-15216C
NAVAL FACILITIES                           30 September 1999
ENGINEERING COMMAND                        ------------------------------
GUIDE SPECIFICATION                        Superseding NFGS-15216B (03/98)
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09/99

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ENGINEERING COMMAND	**------------------------------**
GUIDE SPECIFICATION	**Superseding NFGS-15216B (03/98)**

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SECTION 15216

WELDING PRESSURE PIPING
09/99

****

NOTE: This guide specification covers welding of piping and piping system components which will contain fluids under pressure including hydraulic systems. Piping materials, components, and supports are specified in other sections of the project specifications.

****

****

NOTE: This revision "C" to NFGS-15216 amends the issue dated 31 March 1998 by revising the submittal article to comply with the agreement reached by the SPECSINTACT Tri-Agency Committee.

****

****

NOTE: The following information shall be shown on the project drawings:

1. Tensile strength, elongation, shear strength, size, length, type, and location of the welds, as necessary.

2. The project drawings should be checked to ensure that any supplementary information required by the paragraphs has been shown and that there is no conflict between the drawings and the specifications. See also Note in paragraph entitled "Definitions." The project drawings must indicate, or text of the project specifications must specify, the tensile strength, elongation, shear strength, size, length, type, and location of the welds, as necessary.

****

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API STD 1104	(1994) Welding of Pipelines and Related Facilities

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1	(1995) Power Piping
ASME B31.3	(1996) Process Piping
ASME/ANSI B31.4	(1992) Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols
ASME/ANSI B31.5	(1992; Errata 1993) Refrigeration Piping
ASME/ANSI B31.9	(1996) Building Services Piping
ASME BPVC SEC I	(1995; Addenda 1995 and 1996) Boiler and Pressure Vessel Code: Section I Power Boilers
ASME BPVC SEC II-C	(1995; Addenda 1995 and 1996) Boiler and Pressure Vessel Code: Section II Material Part C - Welding Rods, Electrodes, and Filler Metals
ASME BPVC SEC V	(1995; Addenda 1995 and 1996) Boiler and Pressure Vessel Code: Section V Nondestructive Examination
ASME BPVC SEC IX	(1995; Addenda 1995 and 1996) Boiler and Pressure Vessel Code: Section IX Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING, INC. (ASNT)

ASNT SNT-TC-1A	(1992) Recommended Practice

AMERICAN WELDING SOCIETY, INC. (AWS)

AWS A2.4	(1993) Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0	(1994) Welding Terms and Definitions Including Terms for Brazing, Soldering Thermal Spraying and Thermal Cutting
AWS D1.1	(1996) Structural Welding Code - Steel
AWS D10.9	(1980) Qualification of Welding Procedures and Welders for Piping and Tubing

AWS QC1	(1988) AWS Certification of Welding Inspectors
ANSI/AWS Z49.1	(1994) Safety in Welding, Cutting and Allied Processes

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1926	Safety and Health Regulations for Construction

1.2 RELATED REQUIREMENTS

****

NOTE: The project drawings should be checked to ensure that any supplementary information required by the paragraphs has been shown and that there is no conflict between the drawings and the specifications.

****

Section 15050, "Basic Mechanical Materials and Methods" applies to this section with the additions and modifications specified herein.

1.3 DEFINITIONS

****

NOTE: Insert the applicable ANSI piping codes. ANSI B31.2, "Fuel Gas Piping," and ASME B31.8, "Gas Transmission and Distribution Piping Systems," not listed under paragraph entitled "References," may be used.

****

AWS A3.0 [and applicable ANSI piping documents].

1.4 SUBMITTALS

****

NOTE: Where a "G" in submittal tags follows a submittal item, it indicates Government approval for that item. Add "G" in submittal tags following any added or existing submittal items deemed sufficiently critical, complex, or aesthetically significant to merit approval by the Government. Submittal items not designated with a "G" will be approved by the QC organization.

****

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Welding pressure piping

SD-07 Certificates

Welding procedures qualification

Nondestructive examination (NDE) procedures

NDE personnel certification procedures

Inspector certification

Submit inspector certification and NDE personnel certification for record.

SD-11 Closeout Submittals

Weld identifications

1.5 QUALITY ASSURANCE

1.5.1 Welding Pressure Piping

Show location, length, and type of welds, and indicate postweld heat treatment and nondestructive testing as required.

1.5.2 Procedures

****

NOTE: Insert the applicable ANSI piping codes. ANSI B31.2, "Fuel Gas Piping," and ASME B31.8, "Gas Transmission and Distribution Piping Systems," not listed under paragraph entitled "References," may be used.

****

Develop and qualify procedures for welding metals included in the work. Do not start welding until welding procedures, welders, and welding operators have been qualified. Perform qualification testing by an approved testing laboratory, or by the Contractor if approved by the Contracting Officer in accordance with the qualified procedures. Notify the Contracting Officer at least 24 hours in advance of the time and place of the tests. When practicable, perform the qualification tests at or near the work site. Maintain current records of the test results obtained in welding procedure, welding operator/welder performance qualifications, and nondestructive examination (NDE) procedures. These records shall be readily available at the site for examination by the Contracting Officer.Qualify the procedures for making transition welds between different materials or between plates or pipes of different wall thicknesses. [ANSI Piping] [_____] requirements for branch connections may be used in lieu of detailed designs. Unless otherwise specified, the choice of welding process shall be the responsibility of the Contractor.

1.5.2.1 Previous Qualifications

Welding procedures, welders, and welding operators previously qualified by test may be accepted for the work without requalification provided that the following conditions are fulfilled:

a. Copies of welding procedures, procedure qualification test records, and welder and welding operator performance qualification test records are submitted and approved in accordance with the paragraph entitled "Submittals."

b. Testing was performed by an approved testing laboratory or technical consultant or by the Contractor's approved quality control organization.

c. The welding procedures, welders, and welding operators were qualified in accordance with ASME BPVC SEC IX or AWS D10.9, AR-2 level; and base materials, filler materials, electrodes, equipment, and processes conformed to the applicable requirements of this specification.

d. The requirements of paragraph entitled "Welder and Welding Operator Performance Qualification" for renewal of qualification were met, and records showing name of employer and period of employment using the process for which qualified are submitted as evidence of conformance.

1.5.2.2 Performance

****

NOTE: The paragraphs will be edited and inserted if necessary to ensure proper implementation of the "CONTRACTOR QUALITY CONTROL PROGRAM." The specification writer or design engineer must indicate how much quality control of welding is needed for each project and who is to be responsible, i.e., primarily the Contractor or the Government. If quality control is to be the responsibility of the Government, delete paragraphs entitled "Performance" and "Qualification of Inspection and Nondestructive Examination (NDE) Personnel" through "NDE Personnel Qualification" and renumber paragraphs as necessary. Rarely will a project require 100 percent testing of welds by NDE methods. The designer must determine the required methods and the extent of inspection and testing and must indicate the extent in this or other sections of the project specifications or on the project drawings by notes, nondestructive test symbols, or other means. The referenced applicable publications and Army Technical Manual, "Welding Design, Procedures and Inspection," TM-5-805-7, will be used for guidance in determining inspection and testing requirements. The specifications or project drawings must clearly indicate which joints require 100 percent NDE inspection, which joints require random NDE inspection, and which NDE methods are to be employed for each joint. For random inspection, the project drawings must indicate the location, number of joints, and minimum increment length of weld that will be subject to NDE inspection without predisclosing the exact spots to be examined. Joints not indicated to be tested by NDE methods shall be

subject to visual inspection only. In cases where the nature of the welding is such as to require visual inspection only, the requirements for nondestructive examinations should be deleted from these paragraphs and from paragraph entitled "Qualification of Inspection and Nondestructive Examination (NDE) Personnel."
****

The Contractor shall be responsible for the quality of joint preparation, welding, and examination. Clearly identify and record materials used in the welding operations. The examination and testing defined in this specification are minimum requirements. Provide additional examination and testing as necessary to achieve the quality required.

1.5.3   Welding Procedures Qualification

****
NOTE: The project drawings must indicate, or text of the project specifications must specify, the tensile strength, elongation, shear strength, size, length, type, and location of the welds, as necessary.
****

****
NOTE: Insert the applicable ANSI piping codes. ANSI B31.2, "Fuel Gas Piping," and ASME B31.8, "Gas Transmission and Distribution Piping Systems," not listed under paragraph entitled "References," may be used.
****

Qualification of the welding procedures for each group of materials to be welded is required as indicated in ASME BPVC SEC IX. Record in detail and qualify the "Welding Procedure Specifications" for every welding procedure proposed. Qualification for each welding procedure shall conform to the requirements of ANSI Standards and to this specification. The welding procedures shall specify end preparation for welds, including cleaning, alignments, and root openings. Preheat, interpass temperature control, and postheat treatment of welds shall be as required by ANSI Piping documents, unless otherwise indicated or specified. Describe the type of backing rings or consumable inserts, if used, and, if they are to be removed, the removal process. Welding procedure qualifications shall be identified individually and referenced on the shop drawings or suitably keyed to the contract drawings.

1.5.4   Welder and Welding Operator Performance Qualification

****
NOTE: Insert the applicable ANSI piping codes. ANSI B31.2, "Fuel Gas Piping," and ASME B31.8, "Gas Transmission and Distribution Piping Systems," not listed under paragraph entitled "References," may be used.
****

Qualify each welder and welding operator assigned to work covered by this specification by performance tests using equipment, positions, procedures, base metals, and electrodes or bare filler wires from the same specification, classification, or group number that will be encountered on his assignment. Welders or welding operators who make acceptable procedure qualification tests will be considered performance-qualified for the welding procedure used. Determine performance qualification in accordance with [ASME BPVC SEC IX, [ANSI Piping Standards]] [_____] and as specified.

1.5.5 Renewal of Qualification

Requalification of a welder or welding operator shall be required under one or any combination of the following conditions:

a. When a welder or welding operator has not used the specific welding process for a period of 3 months. The period may be extended to 6 months if the welder has been employed on another welding process.

b. There is specific reason to question the welder's ability to make welds that will meet the requirements of the specifications.

c. The welder or welding operator was qualified by an employer other than those firms performing work under this contract and a qualification test has not been taken within the preceding 12 months. Renewal of qualification under this condition need be made on only a single test joint or pipe of any thickness, position, or material to reestablish qualification for any thickness, position, or material for which the welder or welding operator had qualified previously.

1.5.6 Qualification of Inspection and (NDE) Personnel

Qualification of Inspection and Nondestructive Examination (NDE) Personnel: Qualify inspection and nondestructive examination personnel in accordance with the following requirements:

1.5.6.1 Inspector Certification

Qualify welding inspectors in accordance with AWS QC1.

1.5.6.2 NDE Personnel Certification Procedures

****

NOTE: The paragraphs will be edited and inserted if necessary to ensure proper implementation of the "CONTRACTOR QUALITY CONTROL PROGRAM." The specification writer or design engineer must indicate how much quality control of welding is needed for each project and who is to be responsible, i.e., primarily the Contractor or the Government. If quality control is to be the responsibility of the Government, delete paragraphs entitled "Performance" and "Qualification of Inspection and Nondestructive Examination (NDE) Personnel" through "NDE Personnel Qualification" and renumber paragraphs as necessary. Rarely will a

project require 100 percent testing of welds by NDE methods. The designer must determine the required methods and the extent of inspection and testing and must indicate the extent in this or other sections of the project specifications or on the project drawings by notes, nondestructive test symbols, or other means. The referenced applicable publications and Army Technical Manual, "Welding Design, Procedures and Inspection," TM-5-805-7, will be used for guidance in determining inspection and testing requirements. The specifications or project drawings must clearly indicate which joints require 100 percent NDE inspection, which joints require random NDE inspection, and which NDE methods are to be employed for each joint. For random inspection, the project drawings must indicate the location, number of joints, and minimum increment length of weld that will be subject to NDE inspection without predisclosing the exact spots to be examined. Joints not indicated to be tested by NDE methods shall be subject to visual inspection only. In cases where the nature of the welding is such as to require visual inspection only, the requirements for nondestructive examinations should be deleted from these paragraphs and from paragraph entitled "Qualification of Inspection and Nondestructive Examination (NDE) Personnel."
****

Certify NDE personnel and establish a written procedure for the control and administration of NDE personnel training, examination, and certification. Base procedures on appropriate specific and general guidelines of training and experience recommended by ASNT SNT-TC-1A, [Supplement A-Radiographic] [Supplement B-Magnetic particle] [Supplement C-Ultrasonic] [and] [Supplement D-Liquid Penetrant].

1.5.6.3 Welding Procedures and Qualifications

a. Specifications and Test Results: Submit copies of the welding procedure specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent.

b. Certification: Before assigning welders or welding operators to the work, submit their names, together with certification that each individual is performance qualified as specified. Do not start welding work prior to procedure qualification. The certification shall state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

1.5.7 Symbols

Conform to AWS A2.4.

1.5.7.1 Weld Identifications

Submit a list of the welders' names and symbol for each welder. To identify welds, submit written records indicating the location of welds made by each welder or welding operator.

1.5.8 Safety

Conform to ANSI/AWS Z49.1, 29 CFR 1910-SUBPART Q, "Welding, Cutting, and Brazing," 29 CFR 1926-SUBPART J, "Welding and Cutting."

1.6 ENVIRONMENTAL

Do not perform welding when the quality of the completed weld could be impaired by the prevailing working or weather conditions. The Contracting Officer will determine when weather or working conditions are unsuitable for welding.

1.7 DELIVERY AND STORAGE

Deliver filler metals, electrodes, fluxes and other welding materials to the site in manufacturers' original packages and store in a dry space until used. Label and design packages properly to give maximum protection from moisture and to assure safe handling.

PART 2 PRODUCTS

2.1 WELDING MATERIALS

****

NOTE: Normally, selection of the electrodes is done by the Contractor as part of his qualified welding procedure. In special cases, if the selection of the proper electrode is critical to the design, the designer may specify the electrodes to be used. In special cases it also may be necessary to specify the welding process.

****

Comply with ASME BPVC SEC II-C. Welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures.

PART 3 EXECUTION

3.1 WELDING

Do not deviate from applicable codes, approved procedures and approved shop drawings without prior written approval from the Contracting Officer. Materials or components with welds made off the site will not be accepted if the welding does not conform to the requirements of this specification unless otherwise specified. Assign each welder or welding operator an identifying number, letter, or symbol that shall be used to identify his welds. Each welder or welding operator shall apply his mark adjacent to his weld using an approved rubber stamp or felt-tipped marker with permanent, weatherproof ink or other approved methods that do not deform the metal. For seam welds, place identification marks adjacent to the welds at 3 foot intervals. Confine identification by die stamps or electric etchers to the weld reinforcing crown, preferably in the finished crater.

3.2 WELDING OPERATORS

Perform welding in accordance with qualified procedures using qualified welders and welding operators.

3.3 SUPPORTS

Welding of hangers, supports, and plates to structural members shall conform to AWS D1.1.

3.4 EXAMINATIONS AND TESTS

****

NOTE: The paragraphs will be edited and inserted if necessary to ensure proper implementation of the "CONTRACTOR QUALITY CONTROL PROGRAM." The specification writer or design engineer must indicate how much quality control of welding is needed for each project and who is to be responsible, i.e., primarily the Contractor or the Government. If quality control is to be the responsibility of the Government, delete paragraphs entitled "Performance" and "Qualification of Inspection and Nondestructive Examination (NDE) Personnel" through "NDE Personnel Qualification" and renumber paragraphs as necessary. Rarely will a project require 100 percent testing of welds by NDE methods. The designer must determine the required methods and the extent of inspection and testing and must indicate the extent in this or other sections of the project specifications or on the project drawings by notes, nondestructive test symbols, or other means. The referenced applicable publications and Army Technical Manual, "Welding Design, Procedures and Inspection," TM-5-805-7, will be used for guidance in determining inspection and testing requirements. The specifications or project drawings must clearly indicate which joints require 100 percent NDE inspection, which joints require random NDE inspection, and which NDE methods are to be employed for each joint. For random inspection, the project drawings must indicate the location, number of joints, and minimum increment length of weld that will be subject to NDE inspection without predisclosing the exact spots to be examined. Joints not indicated to be tested by NDE methods shall be subject to visual inspection only. In cases where the nature of the welding is such as to require visual inspection only, the requirements for nondestructive examinations should be deleted from these paragraphs and from paragraph entitled

"Qualification of Inspection and Nondestructive Examination (NDE) Personnel."

****

****

NOTE: Information based on the two tables must be developed and included in each project specification. Tables must clearly define the systems to be inspected and the type of NDE required. Specify 100 percent NDE when required by DM-22 and 49 CFR 195, as covered by paragraph entitled "Piping Subject to 100 percent NDE."

****

Visual and nondestructive examinations shall be performed [by the Government] [by the Contractor] to detect surface and internal discontinuities in completed welds. [Employ the services of a qualified commercial inspection or testing laboratory or technical consultant approved by the Contracting Officer.] Visually examine welds [Radiographic,] [Liquid penetrant,] [Magnetic particle,] [or] [Ultrasonic] examination shall be required as indicated in Tables [IV] [and] [V] attached to this section [or in accordance with other sections where detailed requirements are specified]. Random NDE testing applies to ASME B31.3 and ASME/ANSI B31.4 piping unless specified otherwise. When examination and testing indicates defects in a weld joint, a qualified welder shall repair the weld in accordance with the paragraph entitled "Corrections and Repairs" of this section.

3.4.1 Random NDE Testing

****

NOTE: The paragraphs will be edited and inserted if necessary to ensure proper implementation of the "CONTRACTOR QUALITY CONTROL PROGRAM." The specification writer or design engineer must indicate how much quality control of welding is needed for each project and who is to be responsible, i.e., primarily the Contractor or the Government. If quality control is to be the responsibility of the Government, delete paragraphs entitled "Performance" and "Qualification of Inspection and Nondestructive Examination (NDE) Personnel" through "NDE Personnel Qualification" and renumber paragraphs as necessary. Rarely will a project require 100 percent testing of welds by NDE methods. The designer must determine the required methods and the extent of inspection and testing and must indicate the extent in this or other sections of the project specifications or on the project drawings by notes, nondestructive test symbols, or other means. The referenced applicable publications and Army Technical Manual, "Welding Design, Procedures and Inspection," TM-5-805-7, will be used for guidance in determining inspection and testing requirements. The specifications or project drawings must clearly indicate which joints require

100 percent NDE inspection, which joints require random NDE inspection, and which NDE methods are to be employed for each joint. For random inspection, the project drawings must indicate the location, number of joints, and minimum increment length of weld that will be subject to NDE inspection without predisclosing the exact spots to be examined. Joints not indicated to be tested by NDE methods shall be subject to visual inspection only. In cases where the nature of the welding is such as to require visual inspection only, the requirements for nondestructive examinations should be deleted from these paragraphs and from paragraph entitled "Qualification of Inspection and Nondestructive Examination (NDE) Personnel."
****

****
NOTE: This paragraph will be deleted when the Contractor is not required to perform random inspection. Edit to delete any listed nondestructive test method which is inapplicable. Insert a number from 1 to 99 for percent of welds to be randomly inspected; 10 percent is recommended for most projects.
****

When [radiographic,] [liquid penetrant,] [magnetic particle,] [or] [ultrasonic] examination is required, test a minimum of [10] [_____] percent of the total length or number of piping welds. Randomly select the welds examined, but include an examination of welds made by each welding operator or welder. If random testing reveals that a weld fails to meet minimum quality requirements, examine an additional [10] [_____] percent of the welds in that same group. If the additional welds examined meet the quality requirements, the entire group of welds represented shall be accepted and the defective welds shall be repaired. If any of the additional welds examined also fail to meet the quality requirements, that entire group of welds shall be rejected. Remove and reweld rejected welds or examine rejected welds 100 percent and remove and reweld defects.

3.4.2 Visual Examination

Visually examine welds as follows:

a. Before welding -- for compliance with requirements for joint preparation, placement of backing rings or consumable inserts, alinement and fit-up, and cleanliness.

b. During welding -- for conformance to the qualified welding procedure.

c. After welding -- for cracks, contour and finish, bead reinforcement, undercutting, overlap, and size of fillet welds.

3.4.3 Nondestructive Examination

****

NOTE: Delete any nondestructive test method not required. If magnetic particle inspection is required, specify whether wet or dry particle method is appropriate.
****

NDE shall be in accordance with written procedures. Procedures for [radiographic,] [liquid penetrant,] [magnetic particle,] [or] [ultrasonic] tests and methods shall conform to ASME BPVC SEC V. The approved procedure shall be demonstrated to the satisfaction of the Contracting Officer's QA personnel. In addition to the information required in ASME BPVC SEC V, the written procedures shall include:

a. Timing of the nondestructive examination in relation to the welding operations.

b. Safety precautions.

3.4.4 Examinations and Tests by the Government

Examinations and tests will conform to paragraphs "Visual Examination" and "Nondestructive Examination" of this section, except that destructive tests may be required also. When destructive tests are made, qualified welders or welding operators shall make repairs using welding procedures which will develop the full strength of the members cut. Welding shall be subject to examination and tests in the mill, shop, and field.

3.4.5 Piping Subject to 100 Percent NDE

ASME/ANSI B31.4 [and ASME B31.3] Piping Subject to 100 Percent NDE: 100 percent of each day's girth welds installed in the following locations shall be nondestructively examined 100 percent by radiographic, magnetic particle, or liquid penetrant examination unless impracticable, in which case at least 90 percent must be examined. Nondestructive examination must be impracticable for each girth weld not examined.

a. At onshore locations where a loss of hazardous liquid (petroleum, petroleum products, or anhydrous ammonia) could reasonably be expected to pollute stream, river, lake, reservoir, or other body of water, and any offshore area;

b. Within railroad or public road rights-of-way;

c. At overhead road crossings and within tunnels;

d. Within the limits of any incorporated subdivision of a State government; and

e. Within populated areas, including, but not limited to, residential subdivisions, shopping centers, schools, designated commercial areas, industrial facilities, public institutions, and places of public assembly.

3.5 ACCEPTANCE STANDARDS

****
NOTE: These acceptance standards are taken from ASME B31.1 and are suitable for most jobs. Evaluations of indications as given in ASME B31.1

are applicable to these standards. Visual acceptance standards are given for some other piping codes. It should be noted that specific project design requirements may necessitate revision or expansion to cover different items of work and varying standards of acceptance.

****

3.5.1 Visual

The following indications are unacceptable:

a. Cracks--external surface.

****

NOTE: In the text below, if only ASME B31.3 is applicable, delete all text in brackets. For ASME B31.3 under normal service conditions, use 25 percent with text in brackets and omit last sentence in brackets. For ASME/ANSI B31.4 use 12.5 percent, and add the material in brackets pertaining to B31.4. Consider use of ASME B31.1 acceptance standard for codes other than B31.3 and B31.4.

****

b. Undercut on surface which is greater than 1/32 inchdeep [or [25 percent for ASME B31.3] [and] [12.5 percent for ASME/ANSI B31.4 and ASME/ANSI B31.9] of the wall thickness, whichever is less,] provided that the remaining wall thickness is not less than the minimum design thickness. [For ASME/ANSI B31.4 and in accordance with API STD 1104, undercuts over 1/64 inch through 1/32 inch or over 6 to 12.5 percent of the pipe wall thickness, whichever is smaller, shall not exceed 2 inches in a continuous weld length of 12 inches or 1/6 the length of the weld, whichever is smaller; and undercuts 1/64 inch or 6 percent of the wall thickness, whichever is smaller, are acceptable regardless of length.]

****

NOTE: Include Tables I, II, or III below as applicable to project.

****

c. Weld reinforcement:

(1) ASME B31.1, conform to Table I.

TABLE I
REINFORCEMENT OF GIRTH AND LONGITUDINAL BUTT WELDS

Thickness of Base Metal, inches	Maximum Thickness of Reinforcement for Design Temperature		
	Greater than 750oF inch	350oF-750oF inch	Less Than 350oF inch
Up to 1/8, incl.	1/16	3/32	3/16
Over 1/8 to 3/16, incl.	1/16	1/8	3/16
Over 3/16 to 1/2, incl.	1/16	5/32	3/16
Over 1/2 to 1, incl.	3/32	3/16	3/16
Over 1 to 2, incl.	1/8	1/4	1/4
Over 2	5/32	The greater of 1/4 in. or 1/8 times the width of the weld in inches.	

NOTES:
1. For double welded butt joints, this limitation on reinforcement given above shall apply separately to both inside and outside surfaces of the joint.
2. For single welded butt joints, the reinforcement limits given above shall apply to the outside surface of the joint only.
3. The thickness of weld reinforcement shall be based on the thickness of the thinner of the materials being joined.
4. The weld reinforcement thicknesses shall be determined from the higher of the abutting surfaces involved.
5. Weld reinforcement may be removed if so desired.

(2) ASME B31.3, conform to Table II.

TABLE II

Wall Thickness, Inches	Height, Inches
Less than or equal to 1/4	Less than or equal to 1/16
Greater than 1/4, is less than or equal to 1/2	Less than or equal to 1/8
Greater than 1/2, is less than or equal to 1	Less than or equal to 5/32
Greater than 1	Less than or equal to 3/16

NOTES:
1. Wall thickness is the nominal wall thickness of the thinner of components joined by butt weld.
2. Height: For "Normal Service" and "Severe Cyclic" conditions, use the listed value. For "Category D Fluid Service," use twice the listed value. Measure from surfaces of adjacent components. The lesser of the two measurements, in any plane through the weld, shall not exceed the applicable value at right. Weld metal shall merge smoothly into component surfaces.

TABLE II

Wall Thickness, Inches	Height, Inches

(3) ASME/ANSI B31.4, conform to Table I for under 350 degrees F.

(4) ASME/ANSI B31.5, conform to Table III.

TABLE III

Pipe Wall Thickness, inches	Reinforcement Thickness, inches
1/4 and under	1/16
Over 1/4 through 1/2	3/32
Over 1/2, through 1	1/8
Over 1	3/16

(5) ASME/ANSI B31.9: Thickness of weld reinforcement shall not exceed 3/16 inch.

d. Lack of fusion on surface.

e. Incomplete penetration (applies only when inside surface is readily accessible).

f. Convexity of fillet weld surface greater than 10 percent of longest leg plus 0.03 inch.

g. Concavity in groove welds.

h. Concavity in fillet welds greater than 1/16 inch.

i. Fillet weld size less than indicated or greater than 1 1/4 times the minimum specified fillet leg length.

3.5.2 Magnetic Particle Examination

The following relevant indications are unacceptable:

a. Any cracks and linear indications.

b. Rounded indications with dimensions greater than 3/16 inch.

c. Four or more rounded indications in a line separated by 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 6 square inches of surface, with the major dimension of this area not to exceed 6 inches, with the area taken in the most unfavorable location relative to the indications being evaluated.

3.5.3 Liquid Penetrant Examination

Indications whose major dimensions are greater than 1/16 inch shall be considered relevant. The following relevant indications are unacceptable:

a. Any cracks or linear indications.

b. Rounded indications with dimensions greater than 3/16 inch.

c. Four or more rounded indications in a line separated by 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 6 square inches of surface, with the major dimension of this area not to exceed 6 inches, with the area taken in the most unfavorable location relative to the indications being evaluated.

3.5.4 Radiography

Welds that are shown by radiography to have any of the following discontinuities are unacceptable:

a. Any type of crack or zone of incomplete fusion or penetration.

b. Any other elongated indication which has a length greater than:

(1) 1/4 inch for t up to 3/4 inch, inclusive;

(2) 1/3 t for t from 3/4 inch to 2 1/4 inches, inclusive;

(3) 3/4 inch for t over 2 1/4 inches where t is the thickness of the thinner portion of the weld.

("t" pertains to the thickness of the weld being examined. If a weld joins two members having different thickness at the weld, "t" is the thinner of these two thicknesses.)

c. Any group of indications in line that have an aggregate length greater than t in a length of 12t, except where the distance between the successive indications exceeds 6L where L is the longest indication in the group.

d. Porosity in excess of that shown acceptable in Appendix A-250, Acceptance Standard for Radiographically Determined Rounded Indications in Welds, ASME BPVC SEC I.

3.5.5 Ultrasonic Examination

Permitted for ASME B31.3 and ASME/ANSI B31.4 piping only. Linear type discontinuities are unacceptable if the amplitude exceeds the reference level and discontinuities have lengths which exceed the following:

a. 1/4 inch for t up to 3/4 inch

b. 1/3 t for t from 3/4 inch to 2 1/4 inches

c. 3/4 inch for t over 2 1/4 inches

("t" is the thickness of the weld being examined. If the weld joins two members having different thickness at the weld, "t" is the thinner of these two thicknesses. Discontinuities are interpreted to be cracks, lack of fusion, and incomplete penetration are unacceptable regardless of length.)

3.6 CORRECTIONS AND REPAIRS

****
NOTE: Insert the applicable ANSI piping codes. ANSI B31.2, "Fuel Gas Piping," and ASME B31.8, "Gas Transmission and Distribution Piping Systems," not listed under paragraph entitled "References," may be used.
****

Remove defects and replace welds as specified in [ANSI Piping Standards] [_____], unless otherwise specified. Repair defects discovered between weld passes before additional weld material is deposited. Wherever a defect is removed, and repair by welding is not required, the affected area shall be blended into the surrounding surface eliminating sharp notches, crevices, or corners. After defect removal is complete and before rewelding, reexamine the area by the same test methods which first revealed the defect to ensure that the defect has been eliminated. After rewelding, reexamine the repaired area by the same test methods originally used for that area. For repairs to base material, the minimum examination shall be the same as required for butt welds. Indication of a defect shall be regarded as a defect unless reevaluation by NDE or by surface conditioning shows that no unacceptable indications are present. The use of foreign material to mask, fill in, seal, or disguise welding defects will not be permitted.

****
NOTE: Regarding Table IV, information based on the table must be developed and included in each project specification. Tables must clearly define the systems to be inspected and the type of NDE required. Specify 100 percent NDE when required by DM-22 and 49 CFR 195, as covered by paragraph entitled "Piping Subject to 100 Percent NDE." Where appears, select 100 percent or random but not both.
****

TABLE IV
EXAMINATIONS AND TESTS FOR VARIOUS MATERIALS AND SERVICES

Examinations or Tests Required

Material or Application	Visual	Radiographic	[Magnetic Particle] [or] [Liquid Penetrant]	Ultra-sonic
High-alloy austenitic or nickel steels or nickel alloys for cryogenic service and vacuum service				
a. Tack welds	Yes	No	No	No
b. Root passes	Yes	No	Yes	No
c. Intermediate passes	Yes	No	No	No

TABLE IV
EXAMINATIONS AND TESTS FOR VARIOUS MATERIALS AND SERVICES

Examinations or Tests Required

Material or Application	Visual	Radiographic	[Magnetic Particle] [or] [Liquid Penetrant]	Ultra-sonic
d. Completed weld	Yes	100 percent for NPS over 1 1/4 inches 60 percent for NPS 1 1/4 inches and less	Yes(PT only)	Yes for wall thickness 1/2 inch and over
High-alloy austenitic or nickel steels or nickel alloys for other than cryogenic or vacuum service				
a. Tack welds	Yes	No	No No	
b. Root passes	Yes	No	[No] [Yes]	No
c. Intermediate passes	Yes	No	No No	
d. Completed weld	Yes	[100 percent] [Random]	Yes(PT only)	[No] [Yes]
Stainless steel to carbon steel				
a. Completed weld	Yes	[No][Yes] [Random]	Yes(PT only)	No
Carbon steel piping systems				
a. Tack welds	Yes	No	No	No
b. Root passes	Yes	No	[No][Yes MT]	No
c. Intermediate passes	Yes	No	No	No
d. Completed weld	Yes	[100 percent] [Random]	[No][Yes MT]	No

****

NOTE: Regarding Table V, information based on the table must be developed and included in each project specification. Tables must clearly define the systems to be inspected and the type of NDE required. Specify 100 percent NDE when required by DM-22 and 49 CFR 195, as covered by paragraph entitled "Piping Subject to 100 Percent NDE."

****

TABLE V
MANDATORY MINIMUM NONDESTRUCTIVE EXAMINATIONS FOR ASME B31.1 PIPING

	Temperatures over 750 degrees F and at all pressures.	Temperatures between 350 degrees F and 750 degrees F inclusive and at all pressures over 1052 psig gage	All others
Buttwelds (Girth and Longitudinal)	RT for NPS over 2 inches MT or PT for NPS 2 inches and less.	RT for over 2 inch NPS with thickness over 3/4 inch. Visual for all sizes with thickness 3/4 inch or less.	Visual for all sizes and thicknesses.
Welded Branch Connections (Size indicated is Branch Size)	RT for NPS over 2 inch MT or PT for NPS 2 inch and less.	RT for branch over 4 inch NPS and thickness of branch over 3/4 inch. Visual for all sizes with branch thickness 3/4 inch or less.	Visual for all sizes and thicknesses.
Fillet, Socket Welds	PT or MT for all sizes and thicknesses.	Visual for all sizes and thicknesses.	Visual for all sizes and thicknesses.

NOTES:
1. Thickness refers to pressure boundary wall thickness (such as pipe wall, fitting wall, or nozzle wall thickness).
2. All welds must be given a visual examination in addition to type of specific nondestructive examination specified.
3. NPS-Nominal Pipe Size.
4. RT-Radiographic examination; MT-magnetic particle examination; PT-liquid penetrant examination.
5. RT of branch welds shall be performed before any nonintegral reinforcing material is applied.
6. The thickness of buttwelds is defined as the thicker of the two abutting ends after end preparation.
7. Temperatures and pressures shown are design.
8. In lieu of radiography of welded branch connections when required above, liquid penetrant or magnetic particle examination is acceptable and, when used, shall be performed at the lesser of one-half of the weld thickness or each 1/2 inch of weld thickness and all accessible final weld surfaces.
9. For nondestructive examination of the pressure retaining component, refer to the standards listed in applicable code or the manufacturing specifications.

****

NOTE: Suggestions for improvement of this specification will be welcomed using the Navy "Change Request Forms" subdirectory located in SPECSINTACT in Jobs or Masters under

"Forms/Documents" directory or DD Form 1426. Suggestions should be forwarded to:

Officer In Charge
Seabee Logistics Center
NAVFAC 15G/SLC 46
4111 San Pedro Street
Port Hueneme, CA 93043-4410

FAX: (805) 985-6465/982-5196 or DSN 551-5196
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-- End of Section --

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DEPARTMENT OF THE ARMY
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CEGS-15400 (August 1994)

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 15400

PLUMBING, GENERAL PURPOSE
08/94

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NOTE: This guide specification covers the requirements for general purpose plumbing systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for piping, fixtures, water heaters, pumps, compressed air system, and pressure piping. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****

NOTE: This guide specification covers general

purpose type plumbing systems. This specification essentially implements the requirements of NAPHCC Plumbing Code. Equipment supports and connections, for either equipment on the ground or in the building, will conform to the requirements .
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 700	(1995; Apx C) Specifications for Fluorocarbon and Other Refrigerants
ARI 1010	(1994) Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.10.1	(1993; Z21.10.1a; Z21.10.1b; Z21.10.1c) Gas Water Heaters Vol. I Storage Water Heaters with Input Ratings of 75,000 Btu Per Hour or Less
ANSI Z21.10.3	(1998) Gas Water Heaters Vol. III, Storage Water Heaters with Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous Water Heaters
ANSI Z21.22	(1986; Z21.22a) Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems
ANSI Z21.56	(1994; Z21.56a) Gas-Fired Pool Heaters

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990; R 1995) Ferritic Malleable Iron Castings
ASTM A 47M	(1990; R 1996) Ferritic Malleable Iron Castings
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 74	(1998) Cast Iron Soil Pipe and Fittings
ASTM A 105/A 105M	(1998) Carbon Steel Forgings for Piping Applications
ASTM A 183	(1998) Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	(1998) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 515/A 515M	(1997) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A 516/A 516M	(1990; R 1996) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 518	(1992; R 1997) Corrosion-Resistant High-Silicon Iron Castings
ASTM A 518M	(1992; R 1997) Corrosion-Resistant High-Silicon Iron Castings (Metric)
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 888	(1998) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B 32	(1996) Solder Metal
ASTM B 42	(1996) Seamless Copper Pipe, Standard Sizes
ASTM B 43	(1996) Seamless Red Brass Pipe, Standard Sizes
ASTM B 75	(1997) Seamless Copper Tube
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 88M	(1996) Seamless Copper Water Tube (Metric)
ASTM B 111	(1995) Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM B 117	(1997) Operating Salt Spray (FOG) Apparatus
ASTM B 152	(1997) Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B 152M	(1997) Copper Sheet, Strip, Plate, and Rolled Bar (Metric)
ASTM B 306	(1996) Copper Drainage Tube (DWV)

ASTM B 370	(1992) Copper Sheet and Strip for Building Construction
ASTM B 584	(1996) Copper Alloy Sand Castings for General Applications
ASTM B 641	(1993) Seamless and Welded Copper Distribution Tube (Type D)
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM B 828	(1992) Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM C 564	(1997) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 1053	(1990; R 1995) Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications
ASTM D 638	(1997) Tensile Properties of Plastics
ASTM D 638M	(1997) Tensile Properties of Plastics (Metric)
ASTM D 1004	(1994a) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1248	(1984; R 1989) Polyethylene Plastics Molding and Extrusion Materials
ASTM D 1785	(1996b) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2000	(1998) Rubber Products in Automotive Applications
ASTM D 2235	(1996a) Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D 2239	(1996a) Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM D 2241	(1996b) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2447	(1995) Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter

ASTM D 2464	(1996a) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1997) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(1996a) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2485	(1991; R 1996) Evaluating Coatings for High Temperature Service
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2657	(1997) Heat Fusing Joining Polyolefin Pipe and Fittings
ASTM D 2661	(1997a) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2665	(1998) Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2672	(1996a) Joints for IPS PVC Pipe Using Solvent Cement
ASTM D 2683	(1998) Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D 2737	(1996a) Polyethylene (PE) Plastic Tubing
ASTM D 2822	(1991; R 1997) Asphalt Roof Cement
ASTM D 2846/D 2846M	(1997) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 2996	(1995) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 3035	(1995) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D 3122	(1995) Solvent Cements for Styrene-Rubber (SR) Plastic Pipe and Fittings
ASTM D 3138	(1995) Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure

	Piping Components
ASTM D 3139	(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3261	(1997) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3308	(1997) PTFE Resin Skived Tape
ASTM D 3311	(1994) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM D 4060	(1995) Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D 4101	(1996a) Propylene Plastic Injection and Extrusion Materials
ASTM D 4551	(1996) Poly(Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane
ASTM E 1	(1995) ASTM Thermometers
ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM F 409	(1995) Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings
ASTM F 437	(1993) Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 438	(1993) Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F 439	(1993a) Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 441/F 441M	(1997) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F 442/F 442M	(1997) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
ASTM F 477	(1996) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 493	(1997) Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe

	and Fittings
ASTM F 628	(1997a) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core
ASTM F 891	(1996a) Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core
ASTM F 1290	(1998) Electrofusion Joining Polyolefin Pipe and Fittings
ASTM F 1760	(1997) Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastuc Pipe Having Reprocessed-Recycled Content

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 34	(1992; Addenda a-j) Number Designation and Safety Classification of Refrigerants
ASHRAE 90.1	(1989; 90.1b; 90.1c; 90.1d; 90.1e; 90.1g; 90.1i; 90.1l; 90.1m; 90.1n) Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

ASME INTERNATIONAL (ASME)

ASME A112.1.2	(1991; R 1998) Air Gaps in Plumbing Systems
ASME A112.6.1M	(1997) Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.14.1	(1975; R 1998) Backwater Valves
ASME A112.18.1M	(1996) Plumbing Fixture Fittings
ASME A112.19.1M	(1994; Errata 97, Supplement 1998) Enameled Cast Iron Plumbing Fixtures
ASME A112.19.2M	1998 Vitreous China Plumbing Fixtures
ASME A112.19.3M	(1987; R 1996) Stainless Steel Plumbing Fixtures (Designed for Residential Use)
ASME A112.19.4M	(1994; Errata 1997 and 1998) Porcelain Enameled Formed Steel Plumbing Fixtures
ASME A112.21.1M	(1991; R 1998) Floor Drains
ASME A112.21.2M	(1983) Roof Drains
ASME A112.36.2M	(1991; R 1998) Cleanouts
ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1992) Malleable Iron Threaded Fittings

ASME B16.4	(1992) Gray Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.12	(1998) Cast Iron Threaded Drainage Fittings
ASME B16.15	(1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995; B16.22a) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(1992; Errata Jan 1994) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.24	(1991; R 1998) Cast Copper Alloy Pipe Flanges, Class 150, 300, 400, 600, 900, 1500, and 2500, and Flanged Fittings, Class 150 and 300
ASME B16.29	(1994) Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.34	(1997) Valves - Flanged, Threaded, and Welding End
ASME B16.39	(1986; R 1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.1	(1998) Power Piping
ASME B31.5	(1992; B31.5a) Refrigeration Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME CSD-1	(1998) Controls and Safety Devices for Automatically Fired Boilers

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(1990) Pipe Applied Atmospheric Type Vacuum Breakers

ASSE 1002	(1986) Water Closet Flush Tank Ball Cocks
ASSE 1003	(1995) Water Pressure Reducing Valves for Domestic Water Supply Systems
ASSE 1005	(1986) Water Heater Drain Valves - 3/4-Inch Iron Pipe Size
ASSE 1006	(1989) Residential Use (Household) Dishwashers
ASSE 1011	(1995) Hose Connection Vacuum Breakers
ASSE 1012	(1995) Backflow Preventers with Intermediate Atmospheric Vent
ASSE 1013	(1993) Reduced Pressure Principle Backflow Preventers
ASSE 1018	(1986) Trap Seal Primer Valves Water Supply Fed
ASSE 1037	(1990; Rev thru Mar 1990) Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA EWW	(1995) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C105	(1993) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C203	(1997) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(1997) Grooved and Shouldered Joints
AWWA C700	(1995) Cold-Water Meters - Displacement Type, Bronze Main Case
AWWA D100	(1996) Welded Steel Tanks for Water Storage
AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
AWS B2.2	(1991) Brazing Procedure and Performance

Qualification

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(1997) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(1997) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI HSN-85	(1985) Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings

CODE OF FEDERAL REGULATIONS (CFR)

10 CFR 430	Energy Conservation Program for Consumer Products
21 CFR 175	Indirect Food Additives: Adhesives and Components of Coatings

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-240	(Rev A) Shower Head, Ball Joint
CID A-A-50012	(Basic) Garbage Disposal Machine, Commercial

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA Tube Handbook	(1995) Copper Tube Handbook

COUNCIL OF AMERICAN BUILDING OFFICIALS (CABO)

CABO A117.1	(1992; Errata Jun 1993) Accessible and Usable Buildings and Facilities

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCHR)

FCCCHR-01	(1993) Manual of Cross-Connection Control

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.5	(1994) Centrifugal Pumps

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANCIAL OFFICIALS

IAPMO Z124.1	(1995) Plastic Bathtub Units
IAPMO Z124.3	(1995) Plastic Lavatories
IAPMO Z124.5	(1997) Plastic Toilet (Water Closets) Seats
IAPMO Z124.9	(1993) Plastic Urinal Fixtures

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-44	(1996) Steel PipeLine Flanges
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(1995) Butterfly Valves
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1990) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-73	(1991; R 1996) Brazing Joints for Copper and Copper Alloy Pressure Fittings
MSS SP-78	(1987; R 1992) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves
MSS SP-83	(1995) Class 3000 Steel Pipe Unions Socket-Welding and Threaded
MSS SP-85	(1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends
MSS SP-110	(1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ASSOCIATION OF PLUMBING-HEATING-COOLING CONTRACTORS (NAPHCC)

NAPHCC Plumbing Code	(1996) National Standard Plumbing Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(1997; TIA 97-1) Installation of Oil Burning Equipment

NFPA 54	(1996; Errata) National Fuel Gas Code
NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems

NATIONAL SANITATION FOUNDATION (NSF)

NSF 3	(1996) Commercial Spray-Type Dishwashing and Glasswashing Machines
NSF 5	(1992) Water Heaters, Hot Water Supply Boilers, and Heat Recovery Equipment
NSF 14	(1998) Plastics Piping Components and Related Materials

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA-01	(1991) Plastic Pipe in Fire Resistive Construction

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI G-101	(1996) Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data
PDI WH 201	(1992) Water Hammer Arresters

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J 1508	(1996) Hose Clamps

THE SOCIETY FOR PROTECTIVE COATING (SSPC)

SSPC SP 5/NACE 1	(1994) White Metal Blast Cleaning

UNDERWRITERS LABORATORIES (UL)

UL 174	(1996; Rev thru Nov 1997) Household Electric Storage Tank Water Heaters
UL 430	(1994; Rev thru Oct 1996) Waste Disposers
UL 732	(1995; Rev Oct 1997) Oil-Fired Storage Tank Water Heaters
UL 749	(1997) Household Dishwashers
UL 921	(1996) Commercial Electric Dishwashers

1.2 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Welding

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NOTE: The designer will indicate welding requirements on the project drawings. Normally, delete the second bracketed statement. If the need exists for more stringent requirements for weldments, delete the first bracketed statement and the welding submittal.

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[Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record. Structural members shall be welded in accordance with Section 05090 WELDING, STRUCTURAL.] [Welding and nondestructive testing procedures are specified in Section 05093WELDING PRESSURE PIPING.]

1.3.2 Cathodic Protection and Pipe Joint Bonding

Cathodic protection and pipe joint bonding systems shall be in accordance with [Section 13110 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [and] [Section 13112 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)].

1.4 ELECTRICAL WORK

Motors, motor controllers and motor efficiencies shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor-driven equipment specified herein shall be provided complete with motors. Equipment shall be rated at 60 Hz, single phase, ac unless otherwise indicated. Where a motor controller is not provided in a motor-control center on the electrical drawings, a motor controller shall be as indicated. Motor controllers shall be provided complete with properly sized thermal-overload protection in each ungrounded conductor, auxiliary contact, and other equipment, at the specified capacity, and including an allowable service factor.

1.5 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Welding; [_____].

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

Vibration-Absorbing Features; [_____].

Details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

SD-04 Drawings

Plumbing System; [_____].

Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operations of each system. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

Electrical Schematics; [_____].

Complete electrical schematic lineless or full line interconnection and connection diagram for each piece of mechanical equipment having more than one automatic or manual electrical control device.

SD-06 Instructions

Plumbing System; [_____].

Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

SD-09 Reports

Tests, Flushing and Disinfection ; [_____].

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

Backflow Prevention Assembly Tests; FIO.

Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.

SD-13 Certificates

Materials and Equipment; [_____].

Where materials or equipment are specified to comply with requirements of AGA, or ASME, proof of such compliance. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

Bolts; [_____].

Written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements. The certification shall include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

SD-19 Operation and Maintenance Manuals

Plumbing System; [_____].

[Six] [_____] copies of the operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. [Six] [_____] copies of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

1.6 REGULATORY REQUIREMENTS

Plumbing work shall be in accordance with NAPHCC Plumbing Code.

1.7 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Some materials listed are superior to others

for specific requirements. Therefore, information should be obtained from the using service for any special requirements before selection of material is made. The type of tubing or pipe required will be as determined by local experience. In the absence of actual experience with water characteristics, the selection of materials for pipe, tubing, and tanks will be made by reference to the classification of water into categories as listed in TM 5-810-5/AFM 32-1070. Chap 4.

This specification allows drainage systems up to 375 mm (15 inch) diameter only; designer will ensure the availability of materials when drainage line exceeds 375 mm (15 inch) diameter.

Add working pressure ratings for plastic pipe after material description in Table I.

Plastic traps used in DWV plumbing should be same material as the plumbing.
****

Materials for various services shall be in accordance with TABLES I and II. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service shall bear the NSF seal "NSF-PW." Polypropylene pipe and fittings shall conform to dimensional requirements of Schedule 40, Iron Pipe size. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing lead shall not be used in any potable water system. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors. Plastic pipe shall not be installed in air plenums. Plastic pipe shall not be installed in a pressure piping system in buildings greater than three stories including any basement levels.

2.1.1 Pipe Joint Materials

Grooved pipe and hubless cast-iron soil pipe shall not be used under ground. Joints and gasket materials shall conform to the following:

a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A 74, AWWA C606. For hubless type: CISPI 310

b. Coupling for Steel Pipe: AWWA C606.

c. Couplings for Grooved Pipe: [Ductile Iron ASTM A 536 (Grade 65-45-12)] [Malleable Iron ASTM A 47, Grade 32510]. [Copper ASTM A 536].

d. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.

e. Neoprene Gaskets for Hub and Cast-Iron Pipe and Fittings: CISPI HSN-85.

f. Brazing Material: Brazing material shall conform to AWS A5.8, BCuP-5.

g. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides. Silver brazing materials shall be in accordance with AWS A5.8.

h. Solder Material: Solder metal shall conform to ASTM B 32 95-5 tin-antimony.

i. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B 813, Standard Test 1.

j. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe, ASTM D 3308.

k. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C 564.

l. Rubber Gaskets for Grooved Pipe: ASTM D 2000, maximum temperature 230 degrees F.

m. Flexible Elastomeric Seals: ASTM D 3139, ASTM D 3212 or ASTM F 477.

n. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A 183.

o. Solvent Cement for Transition Joints between ABS and PVC Nonpressure Piping Components: ASTM D 3138.

p. Plastic Solvent Cement for ABS Plastic Pipe: ASTM D 2235.

q. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D 2564 and ASTM D 2855.

r. Plastic Solvent Cement for CPVC Plastic Pipe: ASTM F 493.

s. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105/A 105M. Blind flange material shall conform to ASTM A 516/A 516M cold service and ASTM A 515/A 515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193/A 193M.

t. Plastic Solvent Cement for Styrene Rubber Plastic Pipe: ASTM D 3122.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Water Hammer Arrester: PDI WH 201.

b. Copper, Sheet and Strip for Building Construction: ASTM B 370.

c. Asphalt Roof Cement: ASTM D 2822.

d. Hose Clamps: SAE J 1508.

e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

f. Metallic Cleanouts: ASME A112.36.2M.

g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.

h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines:

AWWA C203.

i. Hypochlorites: AWWA B300.

j. Liquid Chlorine: AWWA B301.

k. Polyethylene Encasement for Ductile-Iron Piping: AWWA C105.

l. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.1.

m. Thermometers: ASTM E 1.

2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.3 VALVES

****

NOTE: Drawings will indicate equipment isolation, branch, and sectionalizing valves for water systems. Valves will be provided so that system maintenance can be performed without complete system shutdown. In general, valves should be provided in the following locations:

a. Each branch serving a group of fixtures.

b. Each riser serving a group of fixtures.

c. Isolation valves will be provided on the supply

and discharge of booster and circulating pumps and on steam coil type domestic water heaters.

d. In nonfreezing climates, wall faucets will be installed on outside walls and lawn faucets in parking, garden, and lawn areas. In freezing climates, freezeproof wall hydrants will be installed on outside walls and yard hydrants in parking, garden, and lawn areas. Indicate on the drawings height of hydrants and faucets above finished grade.

****

Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Backwater Valves	ASME A112.14.1
Vacuum Relief Valves	ASSE 1001
Water Pressure Reducing Valves	ASSE 1003
Water Heater Drain Valves	ASSE 1005
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves	ANSI Z21.22

Description	Standard
for Hot Water Supply Systems	
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1
	Safety Code No., Part CW, Article 5

2.3.1 Backwater Valves

Backwater valves shall be either separate from the floor drain or a combination floor drain, P-trap, and backwater valve, as shown. Valves shall have cast-iron bodies with cleanouts large enough to permit removal of interior parts. Valves shall be of the flap type, hinged or pivoted, with revolving disks. Hinge pivots, disks, and seats shall be nonferrous metal. Disks shall be slightly open in a no-flow no-backwater condition. Cleanouts shall extend to finished floor and be fitted with threaded countersunk plugs.

2.3.2 Wall Faucets

Wall faucets with vacuum-breaker backflow preventer shall be brass with 3/4 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection. Faucet handle shall be securely attached to stem.

2.3.3 Wall Hydrants

Wall hydrants with vacuum-breaker backflow preventer shall have a nickle-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 3/4 inch exposed hose thread on spout and 3/4 inch male pipe thread on inlet.

2.3.4 Lawn Faucets

Lawn faucets shall be brass, with either straight or angle bodies, and shall be of the compression type. Body flange shall be provided with internal pipe thread to suit 3/4 inch pipe. Body shall be suitable for wrench grip. Faucet spout shall have 3/4 inchexposed hose threads. Faucet handle shall be securely attached to stem.

2.3.5 Yard Hydrants

Yard box or post hydrants shall have valve housings located below frost lines. Water from the casing shall be drained after valve is shut off. Hydrant shall be bronze with cast-iron box or casing guard. "T" handle key shall be provided.

2.3.6 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22. Relief valves for systems where the maximum rate of heat input is less than 200,000 Btuh shall have 3/4 inch minimum inlets, and 3/4 inch outlets. Relief valves for systems where the maximum rate of heat input is greater than 200,000 Btuh shall have 1 inch minimum inlets, and 1 inch outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

2.3.7 Thermostatic Mixing Valves

Mixing valves, thermostatic type, shall be line size and shall be constructed with rough or finish bodies either with or without plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Mixing valves shall maintain water temperature within 5 degrees F of any setting.

2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with NAPHCC Plumbing Code. Fixtures for use by the physically handicapped shall be in accordance with CABO A117.1. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 180 degrees F water temperature. Plumbing fixtures shall be as indicated in paragraph PLUMBING FIXTURE SCHEDULE.

2.4.1 Lavatories

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NOTE: Lavatories installed in male barracks or dormitories and in male gang toilets (three or more water closets) or other types of buildings should be provided with brackets to prevent uplifting. In central toilets allow only enameled cast-iron lavatories.

****

[Enameled cast-iron lavatories shall be provided with two cast-iron or steel brackets secured to the underside of the apron and drilled for bolting to the wall in a manner similar to the hanger plate. Exposed brackets shall be porcelain enameled.] [Vitreous china lavatories shall be provided with two integral molded lugs on the back-underside of the fixture and drilled for bolting to the wall in a manner similar to the hanger plate.]

2.4.2 Automatic Flushing System

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NOTE: Include if automatic flushing system is required by the user, and only on handicapped designated water closets.

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Flushing system shall consist of solenoid-activated flush valve with [electrical-operated light beam sensor] [pushbutton] to energize solenoid. Flushing devices shall be provided as described in paragraph FIXTURES AND FIXTURE TRIMMINGS.

2.5 BACKFLOW PREVENTERS

****

NOTE: Indicate on the drawings all locations where backflow preventers are required to protect water supply and distribution system against backflow and backsiphonage in accordance with NAPHCC Plumbing Code. If a drain is required, ensure it is shown. Backflow prevention device requirements for connection to nongovernment potable water systems will be coordinated with the local jurisdiction and/or water service agency.

****

Backflow preventers shall be approved and listed by the Foundation For Cross-Connection Control & Hydraulic Research. Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with FCCCHR-01. Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Air gaps in plumbing systems shall conform to ASME A112.1.2.

2.6 DRAINS

2.6.1 Floor and Shower Drains

Floor and shower drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded or caulked connection. In lieu of a caulked joint between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C 564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor and shower drains shall conform to ASME A112.21.1M.

2.6.1.1 Metallic Shower Pan Drains

Where metallic shower pan membrane is installed, polyethylene drain with corrosion-resistant screws securing the clamping device shall be provided. Polyethylene drains shall have fittings to adapt drain to waste piping. Polyethylene for floor drains shall conform to ASTM D 1248. Drains shall have separate cast-iron "P" trap, circular body, seepage pan, and strainer, unless otherwise indicated.

2.6.1.2 Drains and Backwater Valves

Drains and backwater valves installed in connection with waterproofed floors or shower pans shall be equipped with bolted-type device to securely clamp flashing.

2.6.2 Area Drains

Area drains shall be plain pattern with polished stainless steel perforated or slotted grate and bottom outlet. The drain shall be circular or square with a 12 inch nominal overall width or diameter and 10 inch nominal overall depth. Drains shall be cast iron with manufacturer's standard coating. Grate shall be easily lifted out for cleaning. Outlet shall be suitable for inside caulked connection to drain pipe. Drains shall conform to ASME A112.21.1M.

2.6.3 Floor Sinks

Floor sinks shall be [circular] [square], with 12 inch nominal overall width or diameter and 10 inch nominal overall depth. Floor sink shall have an acid-resistant enamel interior finish with cast-iron body, aluminum sediment bucket, and perforated grate of cast iron in industrial areas and stainless steel in finished areas. The outlet pipe size shall be as indicated or of the same size as the connecting pipe.

2.6.4 Boiler Room Drains

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NOTE: Boiler room drain will be used where coal is the heating fuel.

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Boiler room drains shall have combined drain and trap, hinged grate, removable bucket, and threaded brass cleanout with brass backwater valve. The removable galvanized cast-iron sediment bucket shall have rounded corners to eliminate fouling and shall be equipped with hand grips. Drain shall have a minimum water seal of 4 inches. The grate area shall be not less than 100 square inches.

2.6.5 Pit Drains

Pit drains shall consist of a body, integral seepage pan, and nontilting perforated or slotted grate. Drains shall be of double drainage pattern suitable for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drain pipe. Membrane or flashing clamping device shall be provided when required. Drains shall be cast iron with manufacturer's standard coating. Drains shall be circular and provided with bottom outlet suitable for inside caulked connection, unless otherwise indicated. Drains shall be provided with separate cast-iron "P" traps, unless otherwise indicated.

2.6.6 Sight Drains

Sight drains shall consist of body, integral seepage pan, and adjustable strainer with perforated or slotted grate and funnel extension. The strainer shall have a threaded collar to permit adjustment to floor thickness. Drains shall be of double drainage pattern suitable for embedding in the floor construction. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane shall be provided for other than concrete construction. Drains shall have a galvanized heavy cast-iron body and seepage pan and chromium-plated bronze, nickel-bronze, or nickel-brass strainer and funnel combination. Drains shall be provided with threaded or caulked connection and with a separate cast-iron "P" trap, unless otherwise indicated. Drains shall be circular, unless otherwise indicated. The funnel shall be securely mounted over an opening in the center of the strainer. Minimum dimensions shall be as follows:

Area of strainer and collar	36 square inches
Height of funnel	3-3/4 inches
Diameter of lower portion of funnel	2 inches
Diameter of upper portion of funnel	4 inches

2.6.7 Roof Drains and Expansion Joints

Roof drains shall conform to ASME A112.21.2M, with dome and integral flange, and shall have a device for making a watertight connection between roofing and flashing. The whole assembly shall be galvanized heavy pattern cast iron. For aggregate surface roofing, the drain shall be provided with a gravel stop. On roofs other than concrete construction, roof drains shall be complete with underdeck clamp, sump receiver, and an extension for the insulation thickness where applicable. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane shall be provided when required to suit the building construction. Strainer openings shall have a combined area equal to twice that of the drain outlet. The outlet shall be equipped to make a proper connection to threaded pipe of the same size as the downspout. An expansion joint of proper size to receive the conductor pipe shall be provided. The expansion joint shall consist of a heavy cast-iron housing, brass or bronze sleeve, brass or bronze fastening bolts and nuts, and gaskets or packing. The sleeve shall have a nominal thickness of not less than 0.134 inch. Gaskets and packing shall be close-cell neoprene, O-ring packing shall be close-cell neoprene of 70 durometer. Packing shall be held in place by a packing gland secured with bolts.

2.7 SHOWER PAN

****
NOTE: Show shower pans on the architectural detail. Shower pans may be omitted for showers located on floors with slab-on-grade construction, unless special local conditions necessitate waterproofing.
****

Shower pan may be copper, or nonmetallic material.

2.7.1 Sheet Copper

Sheet copper shall be 16 ounce weight.

2.7.2 Plasticized Polyvinyl Chloride Shower Pan Material

Material shall be sheet form. The material shall be 0.040 inch minimum thickness of plasticized polyvinyl chloride or chlorinated polyethylene and shall be in accordance with ASTM D 4551.

2.7.3 Nonplasticized Polyvinyl Chloride (PVC) Shower Pan Material

Material shall consist of a plastic waterproofing membrane in sheet form. The material shall be 0.040 inch minimum thickness of nonplasticized PVC and shall have the following minimum properties:

a. or ASTM D 638:

Ultimate Tensile Strength:	2600 psi
Ultimate Elongation:	398 percent
100 Percent Modulus:	445 psi

b. ASTM D 1004:

Tear Strength:	300 pounds per inch

c. ASTM E 96:

Permeance:	0.008 perms

d. Other Properties:

Specific Gravity:	1.29
PVC Solvent:	Weldable
Cold Crack:	minus -53 degrees F
Dimensional stability, 212 degrees F minus 2.5 percent	
Hardness, Shore A:	89

2.8 TRAPS

Unless otherwise specified, traps shall be plastic per ASTM F 409 or copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall be without a cleanout. Tubes shall be copper alloy with walls not less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 2 inches. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.9 GREASE INTERCEPTOR

Grease interceptor of the size indicated shall be of reinforced concrete, [or precast concrete construction] [or equivalent capacity commercially available steel grease interceptor] with removable three-section, 3/8 inch checker-plate cover, and shall be installed outside the building. Steel grease interceptor shall be installed in a concrete pit and shall be epoxy-coated to resist corrosion as recommended by the manufacturer. Interceptors shall be tested and rated in accordance with PDI G-101. Concrete shall have 3,000 psi minimum compressive strength at 28 days.

2.10 WATER HEATERS

****

NOTE: Coordinate with the HVAC engineer the availability of heating sources and control air in order to make proper selection of bracketed choices.

Show locations of water heaters on the drawings. Also show the type, capacity, etc. of each water heater on the drawings.

Except for gas-fired water heaters, water temperatures in excess of 49 degrees C (120 degrees F) should be obtained by using a booster heater in series with a primary heater. Hot water systems utilizing recirculation systems should be tied into building off-hour controls. When using a gas-fired water heater, thermostatic mixing valves are required to obtain water temperatures below 49 degrees C (120 degrees F).

****

Water heater types and capacities shall be as indicated. Each primary water heater shall have controls with an adjustable range that includes 90 to 120 degrees F. Each gas-fired water heater and booster water heater shall have controls with an adjustable range that includes 120 to 180 degrees F. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and standby heat losses shall conform to TABLE III for each type of water heater specified. The only exception is that storage water heaters and hot water storage tanks having more than 500 gallons storage capacity need not meet the standard loss requirement if the tank surface area is not insulated to R-12.5 and if a standing light is not used. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.10.1   Automatic Storage Type

Heaters shall be complete with [control system,] [control system, temperature gauge, and pressure gauge,] and shall have ASME rated combination pressure and temperature relief valve.

2.10.1.1   Oil-Fired Type

Oil-fired type water heaters shall conform to UL 732.

2.10.1.2   Gas-Fired Type

Gas-fired water heaters shall conform to ANSI Z21.10.1 when input is 75,000 But per hour or less or ANSI Z21.10.3 for heaters with input greater than 75,000 But per hour.

2.10.1.3   Electric Type

Electric type water heaters shall conform to UL 174 with dual heating elements. Each element shall be 4.5 KO. The elements shall be wired so that only one element can operate at a time.

2.10.1.4   Indirect Heater Type

****

NOTE: The titles of the sections covering the applicable systems will be inserted in the blanks.

Cast-iron heads will be used in steam-to-steam or non fired boiler application. Bronze heads will be used in steam-to-water application. Carbon steel heads will be used in water-to-water applications. For most applications, copper coils will be acceptable. Copper-nickel coils will be used with high pressure steam, 1.034 map (150 psi) or above, high temperature water, or salty water conditions. Single wall type exchangers may be allowed if the requirements in the plumbing code are satisfied (one requirement is that the heat transfer medium is potable or recognized as safe). The option for phenolic resin coating for heaters with service water in the shell and steam or hot water in the coil should be used only at locations where scaling on coil surfaces due to water hardness is severe or where corrosion-induced leaks are a severe problem.

****

Steam and high temperature hot water (HTHW) heaters shall be the assembled product of one manufacturer, and be ASME tested and "U" stamped to code requirements under ASME BPV VIII Div 1. The storage tank shall be as specified in paragraph HOT-WATER STORAGE TANKS. The heat exchanger shall be double wall type that separates the potable water from the heat transfer medium with a space vented to the atmosphere in accordance with NAPHCC Plumbing Code. [The coil shall be coated as specified in paragraph Water Heater, Phenolic Resin Coatings.]

a. HTHW Energy Source: The heater element shall have a working pressure of 400 psig with water at a temperature of 400 degrees F. The heating surface shall be based on 1 square foot of heating surface to heat 20 gallons or more of water in 1 hour from 40 to 180 degrees F using hot water at a temperature of 350 degrees F. Carbon steel heads shall be used. Tubing shall conform to ASTM B 111, Copper Alloy No. 706 (90-10 copper-nickel). Heating elements shall withstand an internal hydrostatic pressure of 600 psig for not less than 15 seconds without leaking or any evidence of damage.

b. Steam Energy Source: The heater element shall have a working pressure of 150 pounds per square inchgauge (psig) with steam at a temperature of 365 degrees F. The heating surface shall be based on 1 square foot of heating surface to heat 20 gallons or more of water in 1 hour from 40 to 180 degrees F using steam at atmospheric pressure. [Cast iron] [bronze] heads shall be used. Tubing shall be light-drawn copper tubing conforming to ASTM B 75. Heating elements shall withstand an internal hydrostatic pressure of 225 psig for not less than 15 seconds without leaking or any evidence of damage.

2.10.2 Instantaneous Water Heater

Heater shall be crossflow design with service water in the coil and [steam] [hot water] in the shell. An integral internal controller shall be provided, anticipating a change in demand so that the final temperature can be maintained under all normal load conditions when used in conjunction with [pneumatic control system] [pilot-operated temperature control system]. Unit shall be manufactured in accordance with ASME BPV VIII Div 1, and shall be certified for 150 psi working pressure in the shell and 150 psi working pressure in the coils. Shell shall be carbon steel with copper lining. Heads shall be [cast iron] [bronze] [carbon steel plate with copper lining]. Coils shall be [copper] [copper-nickel]. Shell shall have metal sheathed fiberglass insulation, combination pressure and temperature relief valve, and thermometer. Insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.10.3 Phenolic Resin Coatings

****

NOTE: If interior erosion of the tubes at or near the tube sheet is expected to be a severe problem, change the wording of this paragraph and its subparagraphs to require the coating to be applied to the first 125 to 200 mm (5 to 8 inches) inside the tubes by brushing.

****

The phenolic resin coating shall be applied at either the coil or coating manufacturer's factory. The coil shall be chemically cleaned to remove any scale if present and to etch the metal surface. The exposed exterior surface of the coil shall be abrasively cleaned to white metal blast in accordance with SSPC SP 5/NACE 1. The coating shall be a product specifically intended for use on the material the water heating coils are made of. Steel, copper, copper alloy, or stainless steel coatings shall be capable of withstanding temperatures up to 400 degrees F dry bulb; and meet the requirements of 21 CFR 175. [The entire exterior surface] [and] [the first 5 to 8 inches inside the tubes] of each coil shall be coated with three component phenolic resin coating system. The system shall consist of the following: wash primer, pigmented base coat, the clear top coat. Immediate and final cure times and temperatures shall be as recommended by the coating manufacturer.

2.10.3.1 Wash Primer

The wash primer shall be composed of a combination of polyvinyl butyral and a heat hardening phenolic resin. The weight per gallon shall be between 7.0 lbs per gallon minimum and 7.4 lbs. per gallon maximum.

2.10.3.2 Pigmented Base Coat

The pigmented baking phenolic base coat shall consist of heat hardening phenolic resins, suitable pigments of the earth type, and softening agents, and shall not contain drying oils or cellulose material. The weight per gallon shall be between 10.3 lbs per gallon minimum and 10.7 lbs per gallon maximum. The non-volatile solids content shall be between 60 percent minimum and 64 percent maximum by weight.

2.10.3.3 Clear Top Coat

The clear non-pigmented baking phenolic top coat shall have a weight per gallon of between 8.65 lbs per gallon minimum and 8.95 lbs per gallon maximum. The non-volatile solids content shall be between 48 percent minimum and 52 percent maximum by weight.

2.10.3.4 Certificate of Compliance

A certificate of compliance shall be submitted by the coating manufacturer that documents successful use of coating system under service conditions indicated on the drawings for a minimum of 2 years at three different locations, and that the coating material and application comply with the testing procedures outlined.

2.10.3.5 Test Panels

Steel test panel substrate shall be 24 gauge in thickness. The panels shall be coated with one coat wash primer, then pigmented baking phenolic to a dry film thickness of 4 to 6 mil, then clear baking phenolic to a total dry film thickness of 5 to 7 mil. The panels shall then be subjected to the tests specified below:

a. Heat Test: Test panel shall be minimum 2-3/4 x 5-7/8 inches in size. A coated test panel shall show no cracking, flaking, or other failure after the panel has been tested in accordance with ASTM D 2485, with a furnace temperature of 400 degrees F.

b. Abrasion Test: A coated test panel shall show no more than a 40 milligram loss when tested in accordance with ASTM D 4060, utilizing a Tabor Abraser CS-17F wheel with a 1000 g weight for 1000 cycles.

c. Corrosion Test: A coated test panel shall show no corrosion after being subjected to a 500 hour salt spray test in accordance with ASTM B 117.

2.11 HOT-WATER STORAGE TANKS

Hot-water storage tanks shall be constructed by one manufacturer, ASME stamped for the working pressure, and shall have the National Board (ASME) registration. The tank shall be cement-lined or glass-lined steel type in accordance with AWWA D100. The heat loss shall conform to TABLE III as determined by the requirements of ASHRAE 90.1. Each tank shall be equipped with a thermometer, conforming to ASTM E 1, Type I, Class 3, Range C, style and form as required for the installation, and with 7 inch scale. Thermometer shall have a separable socket suitable for a 3/4 inch tapped opening. Tanks shall be equipped with a pressure gauge 6 inch minimum diameter face. Insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Storage tank capacity shall be as shown.

2.12 PUMPS

2.12.1 Sump Pumps

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NOTE: Designer will indicate location, sizes, horsepower, and capacities of equipment on drawings. Provide duplex pumps, if discharge capacity is greater than 1.6 liters per second (25 gpm) and total head is at least 6 m (20 feet). Delete "totally enclosed and fan cooled" when not required.

****

Sump pumps shall be of capacities indicated. The pumps shall be of the automatic, electric motor-driven, submerged type, complete with necessary control equipment and with a split or solid cast-iron or steel cover plate. The pumps shall be direct-connected by an approved flexible coupling to a vertical electric motor having a continuous oiling device or packed bearings sealed against dirt and moisture. Motors shall be totally enclosed, fan-cooled of sizes as indicated and shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type [1] [4] enclosed, across-the-line, magnetic controller. Each pump shall be fitted with a high-grade thrust bearing mounted above the floor. Each shaft shall have an alignment bearing at each end, and the suction inlet shall be between 3 and 6 inches above the sump bottom. The suction side of each pump shall have a strainer of ample capacity. A float switch assembly, with the switch completely enclosed in a NEMA 250, Type [1] [4] enclosure, shall start and stop each motor at predetermined water levels. Duplex pumps shall be equipped with an automatic alternator to change the lead operation from one pump to the other, and for starting the second pump if the flow exceeds the capacity of the first pump. The discharge line from each pump shall be provided with a union or flange, a nonclog swing check valve, and a stop valve in an accessible location near the pump.

2.12.2 Circulating Pumps

Domestic hot water circulating pumps shall be electrically driven, single-stage, centrifugal, with mechanical seals, suitable for the intended service. Pump capacities, efficiencies, motor sizes, speeds, and impeller types shall be as shown. Pump and motor shall be [integrally mounted on a cast-iron or steel subbase,] [close-coupled with an overhung impeller,] [or] [supported by the piping on which it is installed]. The shaft shall be one-piece, heat-treated, corrosion-resisting steel with impeller and smooth-surfaced housing of bronze. Motor shall be totally enclosed, fan-cooled and shall have sufficient horsepower for the service required. Pump shall conform to HI 1.1-1.5. Each pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with

"START-STOP" switch in cover. Pump motors smaller than Fractional horsepower pump motors shall have integral thermal overload protection in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Guards shall shield exposed moving parts.

2.12.3 Booster Pumps

2.12.3.1 Centrifugal Pumps

Horizontal split-case centrifugal-type booster pumps shall be furnished. The capacities shall be as shown, and the speed shall not exceed 1800 rpm. Pumps shall have a casing of close-grained iron or steel with smooth water passages. A gasket shall be provided between the upper and lower halves of the casing. Suction and discharge connections shall be flanged. Impellers shall be nonoverloading, bronze, balanced to eliminate vibration, and shall be keyed to corrosion-resisting steel shafts. The casings shall be fitted with bronze wearing or sealing rings. Bearings shall be cartridge type, enabling the entire rotating element to be removed without disturbing alignment or exposing the bearings to dirt, water, and other foreign matter. Pumps shall be provided with mechanical seals. Seal boxes shall be machined in the pump casing and at both sides of the pump, and shall be of sufficient depth to include a conventional bronze seal ring and rows of shaft packing. Bedplates shall be close-grain cast iron or steel with ribs and lugs, complete with foundation bolts, and shall have a drip lip with drain hole. Each pump shall be tested at the manufacturer's plant for operating characteristics at the rated capacity and under specified operating conditions. Test curves shall be furnished showing capacity in gpm, head in feet,efficiency, brake horsepower, and operation in parallel with similar pumps. Multiple pump installations shall have pump characteristics compatible for operation in parallel with similar pumps. The electric motor shall be sized for non-overload when operating at any point along the characteristic curve of the pump. Guards shall shield exposed belts and moving parts.

2.12.3.2 Controls

Each pump motor shall be provided with enclosed across-the-line-type magnetic controller complete in a NEMA 250 Type 1 enclosure with three position, "HAND-OFF-AUTOMATIC," selector switch in cover. Pumps shall be automatically started and stopped by float or pressure switches, as indicated. The pumps shall start and stop at the levels and pressures indicated. A multiposition sequence selector switch shall be provided so that any two pumps may be operated simultaneously beeping a third pump as a standby.

2.12.4 Flexible Connectors

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NOTE: Flexible connectors should be provided for the suction and discharge of each centrifugal pump only as a solution to alignment problems to accommodate retrofits and/or for fluid media temperatures in access of 82 degrees C (180 degrees F).

****

Flexible connectors shall be provided at the suction and discharge of each pump that is 1 hp or larger. Connectors shall be constructed of neoprene, rubber, or braided bronze, with Class 150 standard flanges. Flexible connectors shall be line size and suitable for the pressure and temperature of the intended service.

2.13 WATER PRESSURE BOOSTER SYSTEM

****
NOTE: One of the following systems will be used to boost the water pressure to the value required for service within the building. Indicate location, sizes, horsepower, and capacities of equipment on drawings. Provide duplex pumps, if discharge capacity is greater than 1.6 liter per second (25 gpm) and total head is at least 59.78 kPa (20 feet).
****

2.13.1 Constant Speed Pumping System

Constant speed pumping system with pressure-regulating valves shall employ one lead pump for low flows, and one or more lag pumps for higher flows. Pressure-regulating valves shall be provided with nonslam check feature. The factory prepiped and prewired assembly shall be mounted on a steel frame, complete with pumps, motors, and automatic controls. The system capacity and capacity of individual pumps shall be as indicated. Current sensing relays shall provide staging of the pumps. The pumps shall be protected from thermal buildup, when running at no-flow, by a common thermal relief valve. Pressure gauges shall be mounted on the suction and discharge headers. The control panel shall bear the UL listing label for industrial control panels and shall be in a NEMA 250, Type 1 enclosure. The control panel shall include the following: No-flow shutdown; 7-day time clock; audiovisual alarm; external resets; manual alternation; magnetic motor controllers; time delays; transformer; current relays; "HAND-OFF-AUTOMATIC" switches for each pump; minimum run timers; low suction pressure cutout; and indicating lights for power on, individual motor overload, and low suction pressure. The control circuit shall be interlocked so that the failure of any controller shall energize the succeeding controller.

2.13.2 Hydro-Pneumatic Water Pressure System

An ASME code constructed tank stamped for 125 psig water working pressure shall be provided. The tank shall have a flexible diaphragm made of material conforming to FDA requirements for use with potable water and shall be factory precharged to meet required system pressure.

2.13.3 Variable Speed Pumping System

Variable speed pumping system shall provide system pressure by varying speed and number of operating pumps. The factory prepiped and prewired assembly shall be mounted on a steel frame complete with pumps, variable speed drives, motors, and controls. The variable speed drives shall be the oil-filled type capable of power transmission throughout their complete speed range without vibration, noise, or shock loading. Each variable speed drive shall be run-tested by the manufacturer for rated performance, and the manufacturer shall furnish written performance certification. System shall have suppressors to prevent noise transmission over electric feed lines. Required electrical control circuitry and system function sensors shall be supplied by the variable speed drive manufacturer. The primary power controls and magnetic motor controllers shall be installed in [the controls supplied by the drive manufacturer] [the motor control center]. The sensors shall be located in the system to control drive speed as a function of [constant pump discharge pressure] [constant system pressure at location indicated]. Connection between the sensors and the variable speed drive controls shall be accomplished with [hydraulic sensing lines] [copper wiring] [telemetry]. Controls shall be in NEMA 250, Type 1 enclosures.

2.14 COMPRESSED AIR SYSTEM

2.14.1 Air Compressors

Air compressor unit shall be a factory-packaged assembly, including [_____] phase, [_____] volt motor controls, switches, wiring, accessories, and motor controllers, in a NEMA 250, Type [1] [4] enclosure. Tank-mounted air compressors shall be manufactured to comply with UL listing requirements. Air compressors shall have manufacturer's name and address, together with trade name, and catalog number on a nameplate securely attached to the equipment. Each compressor shall [start and stop automatically at upper and lower pressure limits of the system] [regulate pressure by constant speed compressor loading and unloading] [have a manual-off-automatic switch that when in the manual position, the compressor loads and unloads to meet the demand and, in the automatic position, a time delay relay shall allow the compressor to operate for an adjustable length of time unloaded, then stop the unit]. Guards shall shield exposed moving parts. Each duplex compressor system shall be provided with [automatic] [manual] alternation system. Each compressor motor shall be provided with an across-the-line-type magnetic controller, complete with low-voltage release. An intake air filter and silencer shall be provided with each compressor. Aftercooler and moisture separator shall be installed between compressors and air receiver to remove moisture and oil condensates before the air enters the receiver. Aftercoolers shall be either air- or water-cooled, as indicated. The air shall pass through a sufficient number of tubes to affect cooling. Tubes shall be sized to give maximum heat transfer. Water to unit shall be controlled by a solenoid or pneumatic valve which opens when the compressors start and closes when the compressors shut down. Cooling capacity of the aftercooler shall be sized for the total capacity of the compressors. Means shall be provided for draining condensed moisture from the receiver by an automatic float type trap. Capacities of air compressors and receivers shall be as indicated.

2.14.2 Lubricated Compressors

****

NOTE: Where a suitable compressing station is shown for delivering air to laundries and linen-repair rooms, in addition to the shops, a duplicate compressor will be required for compressing and delivering air. Lubricated type compressors are required for delivery of air to linen repair at 552 kPa (80 psig), laundry at 586 kPa (85 psig), and general laboratories and shops at 345 kPa (50 psig).

****

Compressors shall be two-stage, V-belt drive, capable of operating continuously against their designed discharge pressure, and shall operate at a speed not in excess of 1800 rpm. Compressors shall have the capacity and discharge pressure indicated. Compressors shall be assembled complete on a common subbase. The compressor main bearings shall be either roller or ball. The discharge passage of the high pressure air shall be piped to the air receiver with a copper pipe or tubing. A pressure gauge calibrated to 150 psi and equipped with a gauge cock and pulsation dampener shall be furnished for installation adjacent to pressure switches.

2.14.3 Air Receivers

Receivers shall be designed for 200 psi working pressure. Receivers shall be factory air tested to 1-1/2 times the working pressure. Receivers shall be equipped with safety relief valves and accessories, including pressure gauges and automatic and manual drains. The outside of air receivers may be galvanized or supplied with commercial enamel finish. Receivers shall be designed and constructed in accordance with ASME BPV VIII Div 1 and shall have the design working pressures specified herein. A display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code shall be provided.

2.14.4 Intake Air Supply Filter

****

NOTE: Indicate location and capacities of the air filters on the drawings. Specially filtered air should be provided for all locations, except laundries and garages.

****

Dry type air filter shall be provided having a collection efficiency of 99 percent of particles larger than 10 microns. Filter body and media shall withstand a maximum 125 psi, capacity as indicated.

2.14.5 Pressure Regulators

The air system shall be provided with the necessary regulator valves to maintain the desired pressure for the installed equipment. Regulators shall be designed for a maximum inlet pressure of 125 psi and a maximum temperature of 200 degrees F. Regulators shall be single-seated, pilot-operated with valve plug, bronze body and trim or equal, and threaded connections. The regulator valve shall include a pressure gauge and shall be provided with an adjustment screw for adjusting the pressure differential from 0 to 125 psi. Regulator shall be sized as indicated.

2.15 DOMESTIC WATER SERVICE METER

Cold water meter shall be of the positive displacement type conforming to AWWA C700. Meter register may be round or straight reading type, [indicating [_____]] [as provided by the local utility]. Meter shall be provided with a pulse generator, remote readout register and all necessary wiring and accessories.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Plastic pipe shall not be installed in air plenums. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA-01. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 5 feet outside the building, unless otherwise indicated. A [gate valve] [full port ball valve] [ball valve] and drain shall be installed on the water service line inside the building approximately 6 inches above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 12 inches below the [average local frost depth] [finish grade] or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

3.1.1 Water Pipe, Fittings, and Connections

3.1.1.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific excepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.1.1.5 Pipe Drains

****

NOTE: Designer will indicate location of pipe drains on the drawings.

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Pipe drains indicated shall consist of 3/4 inch hose bibb with renewable seat and [gate] [full port ball] [ball] valve ahead of hose bibb. At other low points, 3/4 inch brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

3.1.1.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets, changes in direction, etc., where indicated and/or required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.1.1.7 Commercial-Type Water Hammer Arresters

****

NOTE: Designer will indicate location and size of commercial-type water hammer arresters on the drawings. Commercial-type water hammer arresters will be sized and located in accordance with PDI WH 201. Piping serving equipment having quick-closing valves shall have suitably sized arresters. For pressures of 450 kPa (65 psi) or less, commercial water hammer arresters may be reduced in number and size, if the system does not contain quick-acting valves. Water pressure regulating or reducing valves may be provided in lieu of commercial-type water hammer arresters, if local use has provided

satisfactory performance. When required, install arresters as close as possible to quick-acting valves, ends of long pipe runs, and near batteries of fixtures.

****

Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to PDI WH 201. Vertical capped pipe columns will not be permitted.

3.1.2 Compressed Air Piping (Non-Oil Free)

Compressed air piping shall be installed as specified for water piping and suitable for 125 psig working pressure. Compressed air piping shall have supply lines and discharge terminals legibly and permanently marked at both ends with the name of the system and the direction of flow.

3.1.3 Joints

****

NOTE: Where environmental conditions do not warrant the use of dielectric unions or flanges the requirement for such unions and flanges will be deleted.

****

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

3.1.3.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

3.1.3.2 Mechanical Couplings

Grooved mechanical joints shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of the pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

3.1.3.3 Union and Flanged

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

3.1.3.4 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

3.1.3.5 Copper Tube and Pipe

The tube or fittings shall not be annealed when making connections. Connections shall be made with a multiflame torch.

a. Brazed. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA Tube Handbook with flux and are acceptable for line sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

b. Soldered. Soldered joints shall be made with flux and are only acceptable for lines 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA Tube Handbook.

c. Copper Tube Extracted Joint. An extracted mechanical joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. Branch tube shall be notched for proper penetration into fitting to ensure a free flow joint. Extracted joints shall be brazed in accordance with NAPHCC Plumbing Code using B-Cup series filler metal in accordance with MSS SP-73. Soldered extracted joints will not be permitted.

3.1.3.6 Plastic Pipe

Acrylonitrile-Butadiene-Styrene (ABS) pipe shall have joints made with solvent cement. PVC and CPVC pipe shall have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

3.1.3.7 Glass Pipe

Joints for corrosive waste glass pipe and fittings shall be made with corrosion-resisting steel compression-type couplings with acrylonitrile rubber gaskets lined with polytetrafluoroethylene.

3.1.3.8 Corrosive Waste Plastic Pipe

Joints for polyolefin pipe and fittings shall be made by mechanical joint or electrical fusion coil method in accordance with ASTM D 2657 and ASTM F 1290. Joints for filament-wound reinforced thermosetting resin pipe shall be made in accordance with manufacturer's instructions. Unions or flanges shall be used where required for disconnection and inspection.

3.1.3.9 Other Joint Methods

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NOTE: Coordinate with paragraph MATERIALS.
****

3.1.4 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.1.5 Corrosion Protection for Buried Pipe and Fittings

3.1.5.1 Cast Iron and Ductile Iron

****
NOTE: For pressure pipe systems delete the protective coating and the cathodic protection system when the soil resistivities at installation depth is above 10,000 ohm-cm. Delete the polyethylene coating for all Air Force projects.
****

Pressure pipe shall have protective coating, a cathodic protection system, and joint bonding. Pipe, fittings, and joints shall have a protective coating. The protective coating shall be completely encasing polyethylene tube or sheet in accordance with AWWA C105. Joints and fittings shall be cleaned, coated with primer, and wrapped with tape. The pipe shall be cleaned, coated, and wrapped prior to pipe tightness testing. Joints and fittings shall be cleaned, coated, and wrapped after pipe tightness testing. Tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.

3.1.5.2 Steel

Steel pipe, joints, and fittings shall be cleaned, coated with primer, and wrapped with tape. Pipe shall be cleaned, coated, and wrapped prior to pipe tightness testing. Joints and fittings shall be cleaned, coated, and wrapped after pipe tightness testing. Tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.

3.1.6 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.1.6.1 Sleeve Requirements

****
NOTE: The designer will detail type of pipe sleeves on the drawings, illustrating method of sealing annular space between pipe and sleeve.
****

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves are not required for cast-iron soil pipe passing through concrete slab on grade, except where penetrating a membrane waterproof floor. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance between bare pipe and inside of sleeve or between jacket over insulation and sleeves. Sleeves in bearing walls shall be steel pipe or cast-iron pipe. Sleeves for membrane waterproof floors shall be steel pipe, cast-iron pipe, or plastic pipe. Membrane clamping devices shall be provided on pipe sleeves for waterproof floors. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. Plastic sleeves shall not be used in nonbearing fire walls, roofs, or floor/ceilings. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with a primer, backstop material and surface preparation as specified in Section 07900 JOINT SEALING. Pipes passing through sleeves in concrete floors over crawl spaces shall be sealed as specified above. The annular space between pipe and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated. Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and [concrete] [masonry] wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant.

3.1.6.2   Flashing Requirements

****

NOTE: The applicable detail plates will be completed and included on the contract drawings. Sleeve thickness and square and rectangular opening details will be determined and indicated on the drawings. Indicate pipe chase areas on the drawings.

****

Pipes passing through roof or floor waterproofing membrane shall be installed through a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 10 inches in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

3.1.6.3 Waterproofing

****
NOTE: Drawings will detail method of attaching waterproofing membranes to sleeves passing through walls or floors that are subject to a static head of water.
****

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 1-1/2 inches to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 1-1/2 inches; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than 8 inches from the drainpipe and shall be lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately 1-1/2 inches to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

3.1.6.4 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

a. A standard roof coupling for threaded pipe up to 6 inches in diameter.

b. A tack-welded or banded-metal rain shield around the pipe.

3.1.6.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing, a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07900 JOINT SEALING.

3.1.7 Fire Seal

****

NOTE: Normally, fire walls and fire partitions will be designated on the architectural drawings.

****

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07840 FIRESTOPPING.

3.1.8 Supports

3.1.8.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

3.1.8.2 Pipe Supports and Structural Bracing, Seismic Requirements

****

NOTE: Provide seismic requirements or piping and related equipment supports and show on the drawings. Delete the phrase

****

Piping and attached valves shall be supported and braced to resist seismic loads as specified in Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT [as shown]. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided. Material used for supports shall be as specified in Section 05120 STRUCTURAL STEEL.

3.1.8.3 Pipe Hangers, Inserts, and Supports

****

NOTE: Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between

panel points in excess of 22.7 kg (50 pounds) shall have the excess hanger loads suspended from panel points.

****

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 39 saddles shall be welded to the pipe.

h. Type 40 shields shall:

(1) Be used on insulated pipe less than 4 inches.

(2) Be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.

(3) Have a high density insert for pipe 2 inches and larger and for smaller pipe sizes when the insulation is suspected of being visibly compressed, or distorted at or near the shield/insulation interface. High density inserts shall have a density of 8 pcf or greater.

i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 120 degrees F for PVC and 180 degrees F for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.

j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.

k. Type 40 shields used on insulated pipe shall have high density inserts with a density of 8 pcf or greater.

l. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

   (1) On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

   (2) On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

   (3) On pipe 4 inches and larger carrying medium less that 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

m. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.

n. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.

o. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.9 Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.10 Pipe Cleanouts

****

NOTE: Specify cast-iron adjustable heads where heads are subject to loads, cleaning agents, and

chemicals which will destroy heads made of plastic materials.
****

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be [cast iron] [or] [plastic].

3.2 WATER HEATERS AND HOT WATER STORAGE TANKS

3.2.1 Relief Valves

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NOTE: A discharge pipe the full size of the relief valve outlet will be shown connected to the outlet and shown on the drawings terminated at a safe location.
****

No valves shall be installed between a relief valve and its water heater or storage tank. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 6 inches above the top of the tank or water heater.

3.2.2 Installation of Gas- and Oil-Fired Water Heater

Installation shall conform to NFPA 54 for gas fired and NFPA 31 for oil fired. Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. An acceptable heat trap may be a piping arrangement such as elbows connected so that the inlet and outlet piping make vertically upward runs of not less than 24 inches just before turning downward or directly horizontal into the water heater's inlet and outlet fittings. Commercially available heat traps, specifically designed by the manufacturer for the purpose of effectively restricting the natural tendency of hot water to rise through vertical inlet and outlet piping during standby periods may also be approved.

3.2.3 Phenolic Resin Application Process

****

NOTE: Where interior erosion of the tubes at or near the tube sheet is a severe problem, the coating may be applied to the first 125 to 200 mm (5 to 8 inches) inside the tubes by brushing.

****

The phenolic resin coating shall be applied at either the coil or coating manufacturer's factory. The [steam] [hot water] coil shall be chemically cleaned to remove any scale if present and to etch the metal surface. The exposed exterior surface of the coil shall be abrasively cleaned to white metal blast in accordance with SSPC SP 5/NACE 1. The exterior surface shall be coated with the three-component coating system in the following sequence and manner. For immediate and final cure times and temperature, the recommendations of the coating manufacturer shall be followed.

a. Wash Primer. One coat of wash primer shall be applied by flooding.

b. Pigmented Base Coat. Pigmented baking phenolic coating shall be applied in several coats by immersion or flooding to a dry film thickness of 4 to 6 mils.

c. Clear Top Coat. Clear non-pigmented baking phenolic top coat shall be applied in several coats by immersion or flooding. The final coat may be applied by spraying. The dry film thickness of the total coating system shall be between 5 and 7 mils.

3.2.4 Heat Traps

****

NOTE: Piping arrangement for the heat trap should be shown on the drawings.

****

Piping to and from each water heater and hot water storage tank shall be routed horizontally and downward a minimum of 2 feet before turning in an upward direction.

3.2.5 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

3.3 FIXTURES AND FIXTURE TRIMMINGS

Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

3.3.1   Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.3.2   Flushometer Valves

****

NOTE: Include bracketed requirement for water closets in male barracks and dormitories. Bumpers for water closet seat on flushometer spud work only with closed front seat.

****

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. [Flushometer valves for water closets shall be installed 39 inches above the floor.] [Bumpers for water closet seats shall be installed on the [wall] [flushometer stop] [flushometer spud].]

3.3.3   Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 31 inches above finished floor. Wall-hung drinking fountains and water coolers shall be installed with rim 42 inches above floor. Wall-hung service sinks shall be mounted with rim 28 inches above the floor. Installation of fixtures for use by the physically handicapped shall be in accordance with CABO A117.1.

3.3.4   Shower Bath Outfits

The area around the water supply piping to the mixing valves and behind the escutcheon plate shall be made watertight by caulking or gasketing.

3.3.5   Fixture Supports

****

NOTE: Project drawings will detail methods of hanging lavatories and wall-hung urinals. Normally, these fixtures will be supported by one of the

methods described.
****

Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.3.5.1   Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

3.3.5.2   Support for Cellular-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the cellular wall using through bolts and a back-up plate.

3.3.5.3   Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

3.3.5.4   Support for Wood Stud Construction

Where floor is a concrete slab, a floor-anchored chair carrier shall be used. Where entire construction is wood, wood crosspieces shall be installed. Fixture hanger plates, supports, brackets, or mounting lugs shall be fastened with not less than No. 10 wood screws, 1/4 inch thick minimum steel hanger, or toggle bolts with nut. The wood crosspieces shall extend the full width of the fixture and shall be securely supported.

3.3.5.5   Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

3.3.6   Backflow Prevention Devices

Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with NAPHCC Plumbing Code at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

3.3.7 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METAL.

3.3.8 Sight Drains

Sight drains shall be installed so that the indirect waste will terminate 2 inches above the flood rim of the funnel to provide an acceptable air gap.

3.3.9 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D 3311. Traps for acid-resisting waste shall be of the same material as the pipe.

3.3.10 Shower Pans

Before installing shower pan, subfloor shall be free of projections such as nail heads or rough edges of aggregate. Drain shall be a bolt-down, clamping-ring type with weepholes, installed so the lip of the subdrain is flush with subfloor.

3.3.10.1 General

The floor of each individual shower, the shower-area portion of combination shower and drying room, and the entire shower and drying room where the two are not separated by curb or partition, shall be made watertight with a shower pan fabricated in place. The shower pan material shall be cut to size and shape of the area indicated, in one piece to the maximum extent practicable, allowing a minimum of 6 inches for turnup on walls or partitions, and shall be folded over the curb with an approximate return of 1/4 of curb height. The upstands shall be placed behind any wall or partition finish. Subflooring shall be smooth and clean, with nailheads driven flush with surface, and shall be sloped to drain. Shower pans shall be clamped to drains with the drain clamping ring.

3.3.10.2 Metal Shower Pans

When a shower pan of required size cannot be furnished in one piece, metal pieces shall be joined with a flatlock seam and soldered or burned. The corners shall be folded, not cut, and the corner seam shall be soldered or burned. Pans, including upstands, shall be coated on all surfaces with one brush coat of asphalt. Asphalt shall be applied evenly at not less than 1 gallon per 50 square feet. A layer of felt covered with building paper shall be placed between shower pans and wood floors. The joining surfaces of metal pan and drain shall be given a brush coat of asphalt after the pan is connected to the drain.

3.3.10.3   Nonplasticized Chlorinated Polyethylene Shower Pans

Corners of nonplasticized chlorinated polyethylene shower pans shall be folded against the upstand by making a pig-ear fold. Hot-air gun or heat lamp shall be used in making corner folds. Each pig-ear corner fold shall be nailed or stapled 1/2 inch from the upper edge to hold it in place. Nails shall be galvanized large-head roofing nails. On metal framing or studs, approved duct tape shall be used to secure pig-ear fold and membrane. Where no backing is provided between the studs, the membrane slack shall be taken up by pleating and stapling or nailing to studding 1/2 inch from upper edge. To adhere the membrane to vertical surfaces, the back of the membrane and the surface to which it will be applied shall be coated with adhesive that becomes dry to the touch in 5 to 10 minutes, after which the membrane shall be pressed into place. Surfaces to be solvent-welded shall be clean. Surfaces to be joined with xylene shall be initially sprayed and vigorously cleaned with a cotton cloth, followed by final coating of xylene and the joining of the surfaces by roller or equivalent means. If ambient or membrane temperatures are below 40 degrees F the membrane and the joint shall be heated prior to application of xylene. Heat may be applied with hot-air gun or heat lamp, taking precautions not to scorch the membrane. Adequate ventilation and wearing of gloves are required when working with xylene. Membrane shall be pressed into position on the drain body, and shall be cut and fit to match so that membrane can be properly clamped and an effective gasket-type seal provided. On wood subflooring, two layers of 15 pound dry felt shall be installed prior to installation of shower pan to ensure a smooth surface for installation.

3.3.10.4   Nonplasticized Polyvinyl Chloride (PVC) Shower Pans

Nonplasticized PVC shall be turned up behind walls or wall surfaces a distance of not less than 6 inches in room areas and 3 inches above curb level in curbed spaces with sufficient material to fold over and fasten to outside face of curb. Corners shall be pig-ear type and folded between pan and studs. Only top 1 inch of upstand shall be nailed to hold in place. Nails shall be galvanized large-head roofing type. Approved duct tape shall be used on metal framing or studs to secure pig-ear fold and membrane. Where no backing is provided between studs, the membrane slack shall be taken up by pleating and stapling or nailing to studding at top inch of upstand. To adhere the membrane to vertical surfaces, the back of the membrane and the surface to which it is to be applied shall be coated with adhesive that becomes dry to the touch in 5 to 10 minutes, after which the membrane shall be pressed into place. Trim for drain shall be exactly the size of drain opening. Bolt holes shall be pierced to accommodate bolts with a tight fit. Adhesive shall be used between pan and subdrain. Clamping ring shall be bolted firmly. A small amount of gravel or porous materials shall be placed at weepholes so that holes remain clear when setting bed is poured. Membrane shall be solvent welded with PVC solvent cement. Surfaces to be solvent welded shall be clean (free of grease and grime). Sheets shall be laid on a flat surface with an overlap of about 2 inches. Top edge shall be folded back and surface primed with a PVC primer. PVC cement shall be applied and surfaces immediately placed together, while still wet. Joint shall be lightly rolled with a paint roller, then as the joint sets shall be rolled firmly but not so hard as to distort the material. In long lengths, about 2 or 3 feet at a time shall be welded. On wood subflooring, two layers of 15 pound felt shall be installed prior to installation of shower pan to ensure a smooth surface installation.

3.4 VIBRATION-ABSORBING FEATURES

****

Indicate on the drawings where equipment should be mounted resiliently. Details for proper mounting of equipment will be indicated on the drawings. Insert required isolation efficiency in the blank space for installations where specific values for reduction of noise and vibration transmission are necessary; otherwise the sentence will be deleted. For areas where the maximum tolerable transmissibility in percent is considered necessary, the isolation efficiency will be given. Recommended transmissibility in percentages are as follows: 10 percent for equipment mounted in very critical areas, 10 to 20 percent for critical areas, and 20 to 40 percent for noncritical areas. The drawings should be checked to ensure that all structural and equipment connection factors or conditions surrounding the equipment, which is to be provided with vibration isolation units, favorably influence the effectiveness of the isolators. Where many items of equipment require different transmission values, because of different equipment locations, the paragraph may be revised to indicate the appropriate values on the drawings.

Delete submittal of Vibration-Absorption Features when not required.

****

Mechanical equipment, including compressors and pumps, shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation shall include an adequate number of standard isolation units. Each unit shall consist of machine and floor or foundation fastening, together with intermediate isolation material, and shall be a standard product with printed load rating. Piping connected to mechanical equipment shall be provided with flexible connectors. Isolation unit installation shall limit vibration to [_____] percent of the lowest equipment rpm.

3.4.1 Tank- or Skid-Mounted Compressors

Floor attachment shall be as recommended by compressor manufacturer.

3.4.2 Foundation-Mounted Compressors

[Foundation attachment shall be as recommended by the compressor manufacturer.] [Foundation shall be as recommended by the compressor manufacturer, except the foundation shall weigh not less than three times the weight of the moving parts.]

3.5 WATER METER REMOTE READOUT REGISTER

The remote readout register shall be mounted at the location indicated or as directed by the Contracting Officer.

3.6 IDENTIFICATION SYSTEMS

3.6.1 Identification Tags

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NOTE: Delete when identification tags are not considered necessary on small projects.
****

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.6.2 PipeColor Code Marking

****
NOTE: Designer will coordinate color code marking with Section 09900. Color code marking for piping not listed in Table I of Section 09900, will be added to the table.
****

Color code marking of piping shall be as specified in Section 09900 PAINTING, GENERAL.

3.6.3 Color Coding Scheme for Locating Hidden Utility Components

****
NOTE: The Color Code Table will be developed to suit the installation. The colors of metal disks used in Army projects will be as directed by the Facilities Engineer. Identification plate specified in Section 09900 PAINTING, GENERAL will be deleted if color coding scheme is specified.
****

Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components shall include valves, dampers, switches, linkages and thermostats. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 3/8 inch in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 3 foot width, 30 inches height, and 1/2 inch thickness. The board shall be made of wood fiberboard and framed under glass or 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. The color code board shall be mounted and located in the mechanical or equipment room. The color code system shall be as indicated below:

Color	System	Item	Location
[_____]	[_____]	[_____]	[_____]

3.7 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.8 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09900 PAINTING, GENERAL.

3.9 TESTS, FLUSHING AND DISINFECTION

3.9.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with NAPHCC Plumbing Code.

a. Drainage and Vent Systems Tests.

b. Building Sewers Tests.

c. Water Supply Systems Tests.

3.9.1.1 Test of Backflow Prevention Assemblies

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies. Gauges shall be tested annually for accuracy in accordance with the University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14). Report form for each assembly shall include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

3.9.1.2 Shower Pans

After installation of the pan and finished floor, the drain shall be temporarily plugged below the weep holes. The floor area shall be flooded with water to a minimum depth of 1 inch for a period of 24 hours. Any drop in the water level during test, except for evaporation, will be reason for rejection, repair, and retest.

3.9.1.3 Compressed Air Piping (Nonoil-Free)

Piping systems shall be filled with oil-free dry air or gaseous nitrogen to 150 psig and hold this pressure for 2 hours with no drop in pressure.

3.9.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

3.9.3 System Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. In general, sufficient water shall be used to produce a minimum water velocity of 2.5 feet per second through piping being flushed. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation.

3.9.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Pump suction and discharge pressures.

f. Temperature of each domestic hot-water supply.

g. Operation of each floor and roof drain by flooding with water.

h. Operation of each vacuum breaker and backflow preventer.

i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.

j. Compressed air readings at each compressor and at each outlet. Each indicating instrument shall be read at 1/2 hour intervals. The report of the test shall be submitted in quadruplicate. The Contractor shall furnish instruments, equipment, and personnel required for the tests; the Government will furnish the necessary water and electricity.

3.9.5 Disinfection

****

NOTE: If government laboratory facilities are available to conduct the bacterial examination of the test samples, revise this paragraph accordingly. The option of having the Contracting Officer perform the sampling and testing will be selected only if Government laboratory facilities are available and with concurrence from appropriate laboratory personnel. At some locations, either county or installation health officers inspect the disinfection process. If this is required, add a notification requirement and give the office to be notified, including phone number. For modification of existing systems, provide special procedures for disinfection of new equipment.

****

After operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. System shall be flushed as specified, before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. The chlorine residual shall be checked at intervals to ensure that the proper level is maintained. Chlorine application shall continue until the entire main is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system being disinfected shall be opened and closed several times during the contact period to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. Water tanks shall be disinfected by the addition of chlorine directly to the filling water. Following a 6 hour period, no less than 50 ppm chlorine residual shall remain in the tank. If after the 24 hour and 6 hour holding periods, the residual solution contains less than 25 ppm and 50 ppm chlorine respectively, flush the piping and tank with potable water, and repeat the above procedures until the required residual chlorine levels are satisfied. The system including the tanks shall then be flushed with clean water until the residual chlorine level is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. Samples of water in disinfected containers shall be obtained from several locations selected by the Contracting Officer. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. Disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.10 PLUMBING FIXTURE SCHEDULE

****

NOTE: In order to maintain sanitary conditions, waterless urinals require that the trap insert be replaced at least every 6 months and that the immiscible barrier liquid be replenished after no more than 500 uses. The designer must insure that responsible installation representatives are aware of these maintenance requirements and approve the use of waterless urinals.

For P-5 Lavatory, pop-up drain shall be used in lieu of strainer for BOQ, BEQ, UOPH, and UEPH.

For P-10 Laboratory Sink, vitreous china sinks shall have a stainless steel drain. Plastic sinks shall have an acid-resisting plastic drain and trap. Enameled cast iron sinks shall have a stainless steel drain.

For P-13 Shower, for EM Barracks and dormitories, vandal-resistant shower heads will be specified. Designer should ensure the facility has adequate water pressure (345-552 kPa (50-80 psi)) for shower head to function properly. At lower pressure (138-345 kPa (20-50 psi)) the shower head's flow may be inadequate. The designer has the option to select an adjustable or nonadjustable spray shower head.

For P-14 Water Fountains will be located outside the hazardous area whenever possible. The designer will add to the specifications required data on construction, supports and insulation.

****

P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, [floor mounted] [wall mounted]. Floor flange shall be copper alloy, cast iron, or plastic.

Gasket shall be wax type.

Seat - IAPMO Z124.5, Type A, [black] [white] [_____] plastic, elongated, open front.

Flushometer Valve - ASSE 1037, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 2-5/8 inches at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 1.6 gallons per flush.

Flush Tank - An adequate quantity of water shall be provided to flush and clean the fixture served. The water supply to flush tanks equipped for manual flushing shall be controlled by a float valve or other automatic device designed to refill the tank after each discharge, and to completely shut off the water flow to the tank when the tank is filled to operational capacity. Water closets having their flush valve seat located below the flood level rim of the closet bowl shall have a ballcock installed within a sheath or in a separate and isolated compartment of the tank, both to have visible discharge onto the floor in case of failure. Provision shall be made to automatically supply water to the fixture so as to refill the trap seal after each flushing. The water supply to flush tanks equipped for automatic flushing shall be controlled by a suitable timing device. Ballcocks shall meet ASSE 1002.

Flush Valve in Flush Tank - Flush valve seats in tanks for flushing water closets shall be at least 1 inch above the flood level rim of the bowl connected thereto, except in approved water closet and flush tank combinations designed so that when the tank is flushed and the fixture is clogged or partially clogged, the flush valve shall close tightly so that water will not spill continuously over the rim of the bowl or back flow from the bowl to the tank.

P-2 WATER CLOSET HANDICAPPED:

Height of top rim of bowl shall be in accordance with CABO A117.1; other features are the same as P-1.

P-3 URINAL:

[Wall hanging, with integral trap and extended shields, ASME A112.19.2M [siphon jet] [washout]. Top supply connection, back outlet.

Flushometer Valve - Similar to Flushometer Valve for P-1. The maximum water use shall be 1 gallon per flush.]

[Wall hanging urinal shall be in accordance with IAPMO Z124.9 and be a waterless, non-flushing type, with replaceable trap insert having circular outer rim opening for flow. The replaceable trap insert shall contain a low specific gravity immiscible barrier liquid. The liquid shall be biodegradable. The urinal shall not require chair carrier. The urinal and trap assembly shall maintain a sufficient barrier of immiscible liquid necessary to inhibit backflow of sewer gases.]

P-4 BATHTUB:

Straight front, recessed, 60 x 32 x 16 in, [enameled cast iron, ASME A112.19.1M raised bottom] [porcelain enameled formed steel with structural composite reinforcement ASME A112.19.4M. Structural reinforcement shall be in accordance with IAPMO Z124.1] including appendix [plastic, IAPMO Z124.1 without wall] [plastic, IAPMO Z124.1 with high wall].

Drain Assembly - Plug, cup strainer, overflow assembly, washers, couplings, pop-up lever, trip lever, stopper, fittings, etc., shall be brass, cast copper alloy, or wrought copper alloy. See paragraph FIXTURES for optional plastic accessories.

P-5 LAVATORY:

Manufacturer's standard sink depth, [enameled cast iron ASME A112.19.1M] [vitreous china ASME A112.19.2M], [straight back] [ledge back] [shelf back] [countertop, rectangular].

Faucet - Faucets shall be [single] [center set] [combination] [single control, mixing] type. [Faucets shall have replaceable seats and washers.] [Faucets shall have metal replaceable cartridge control unit or metal cartridge units with diaphragm which can be replaced without special tools.] Valves and handles shall be copper alloy. Connection between valve and spout for center-set faucet shall be of rigid metal tubing. Flow shall be limited to 0.25 gallon per cycle at a flowing water pressure of 80 psi if a metering device or fitting is used that limits the period of water discharge such as a foot switch or fixture occupancy sensor. If a metering device is not used, the flow shall be limited to 2.5 gpm at a flowing pressure of 80 psi.

Handles - [Index turn] [Lever] [Four arm] [Crown] type. Cast, formed, or drop forged copper alloy.

Drain - [Strainer shall be copper alloy or stainless steel] [Pop-up drain shall include stopper, lift rods, jam nut, washer, and tail piece]. See paragraph FIXTURES for optional plastic accessories.

P-6 WHEELCHAIR LAVATORY:

Vitreous china, ASME A112.19.2M, wheelchair lavatory with wrist or elbow controls 20 inches wide x 27 inches deep with gooseneck spout. Flow shall be limited to 0.25 gallon per cycle at a flowing water pressure of 80 psi if a metering device or fitting is used that limits the period of water discharge such as foot switch or fixture occupancy sensor. If a metering device is not used, the flow shall be limited to 2.5 gpm at a flowing water pressure of 80 psi.

Drain - Strainer shall be copper alloy or stainless steel.

P-7 KITCHEN SINK:

Ledge back with holes for faucet and spout [single bowl [24 x 21 inches] [24 x 30 inches]] [double bowl [32 x 21 inches] [42 x 21 inches]] [enameled cast iron ASME A112.19.1M] [porcelain enameled steel ASME A112.19.4M] [stainless steel ASME A112.19.3M].

Faucet and Spout - Cast or wrought copper alloy. Aerator shall have internal threads. Flow shall be limited to 0.25 gallon per cycle at a flowing water pressure of 80 psi if a metering device or fitting is used that limits the period of water discharge such as a foot switch or fixture occupancy sensor. If a metering device is not used, the flow shall be limited to 2.5 gpm at a flowing water pressure of 80 psi.

Handle - Cast copper alloy, wrought copper alloy, or stainless steel. Single lever type.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

P-8 SERVICE SINK:

Enameled cast iron ASME A112.19.1M, copper alloy or stainless steel ASME A112.19.3M [trap standard 24 inches wide x 20 inches deep, splashback 9 inches high] [wall mounted 24 inches wide x 20 inches deep, splashback 9 inches high] [corner, floor mounted 28 inches square, 6-3/4 inches deep].

Faucet and Spout - Cast or wrought copper alloy, [with] [without] top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be [lever] [four arm] type. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

Trap - Cast iron, minimum 3 inch diameter.

P-9 COMBINATION SINK AND LAUNDRY TRAY:

[ledge back 42 x 25 inch), 4 inch splash back, sink 8 inches deep, tray 12 inches deep)] [counter top 42 x 21 inch, 4 inch splash back, sink 7-1/2 inches deep, tray 10 inches deep)], [left hand] [right hand], [enameled cast iron ASME A112.19.1M] [porcelain enameled steel ASME A112.19.4M].

Faucet and Spout - Cast or wrought copper alloy, [with] [without] top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Strainers shall have internal threads. Combination faucets with two valves and spouts shall be provided.

Handles - Cast or wrought copper alloy. [Indexed turn] [Lever] [Four arm] type.

P-10 LABORATORY SINK:

[ledge back [23 inches wide x 15 inches deep] [30 inches wide x 20 inches deep]] [countertop [20 inches wide x 15 inches deep] [30 inches wide x 20 inches deep]], [vitreous china ASME A112.19.2M] [acid-resistant enameled cast iron ASME A112.19.1M] [acid-resistant plastic IAPMO Z124.3] [corrosion-resisting steel ASME A112.19.3M]. Thickness of sinks shall be manufacturer's standard. [Drain] [drain and trap] shall be [stainless steel] [_____].

Faucet and Spout - Cast or wrought copper alloy, [with] [without] top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Strainers shall have internal threads.

Handles - Cast copper alloy, wrought copper alloy, or stainless steel, lever type.

P-11 SCULLERY SINK:

Stainless steel ASME A112.19.3M with drainboard, 36 x 24 inch compartments, 27 inch deep, 15 inch splashback, [single compartment - 61 inches wide] [double compartment - 108 inches wide] [triple compartment - 138 inches wide]. Drain shall have quick opening valve. Support on stainless steel legs.

Faucet and Spout - Cast or wrought copper alloy, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Strainers shall have internal threads. Combination faucets with two valves and spouts shall be provided.

Handles - Cast copper alloy, wrought copper alloy, or stainless steel, four arm type.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

P-12 LAUNDRY SINK:

Double bowl, [countertop 42 x 21 inches] [ledge back 42 x 24 inches)] [pedestal 48 x 20 inches] [leg support 48 x 20 inches,] [enameled cast iron ASME A112.19.1M] [stainless steel ASME A112.19.3M].

Faucet and Spout - Cast copper alloy, wrought copper alloy, cast iron, or stainless steel, with backflow preventer. Faucets shall have replaceable seat and the stem shall rotate onto the seat. Strainers shall have internal threads. Combination faucets shall be mounted on the tub back. Spouts shall be externally threaded for hose connection.

Handles - Cast copper alloy, wrought copper alloy, or stainless steel, lever type.

Traps - Copper alloy, or cast iron.

P-13 Shower: Shower heads, CID A-A-240 other than emergency showers, shall include a non-removable, tamperproof device to limit water flow to 2.5 gpm when tested in accordance with ASME A112.18.1M.

Wall Mounted: Shower head shall be [adjustable] [nonadjustable] spray, stainless steel or chromium plated brass with ball joint. Handles shall be [chrome-plated die cast zinc alloy] [manufacturer's option]. Control valves shall be copper alloy and have metal integral parts of copper alloy, nickel alloy, or stainless steel. Valves shall be [thermostatic mixing] [pressure reducing] [mechanical mixing, single lever] [separate hot and cold water] type. Shower head shall be vandalproof with integral back.

Column Showers: Column showers shall have a 6 foot column height measured from floor to shower head, 1/2 inch IPS threads.

Bath Showers: Bath showers shall include bathtub spout, shower head, valves, diverters. A shower head mounting [with ball joint] [without ball joint] [with ball joint and head integral with a formed wall plate] [with shower head integral with formed wall plate] shall be provided. Diverter shall be integral with single mixing valves or mounted hot and cold water valves. Tub spout shall be copper alloy.

Cabinet Showers: Free standing cabinet, single unit with receptor; 34 inches wide by 34 inches deep, fiberglass reinforced plastic with terrazzo or plastic receptor. Cabinet shall include curtain rod, trim, and concealed fittings.

Emergency Showers: Head for Emergency and Emergency Eye and Face Wash. Shower control shall be 1 inch or 1-1/2 inch stay-open type control valve. Unit shall be [corrosion-resisting steel] [or] [enameled cast iron] and shall be [wall mounted] [pedestal mounted].

P-14 BUBBLER DRINKING FOUNTAINS:

Bubbler drinking fountains shall have self-closing valves. Self-closing valves shall have automatic stream regulators, flow control capability, a push button actuation or a cross-shaped index metal turn handle without a hood. Spouts shall provide a flow of water at least 4 inches high so as to allow the insertion of a cup or glass under the flow of water. Stops, stream regulators, flow controls, pushbuttons, handles, and traps shall be made of copper zinc alloy. Strainers and drains shall be made of copper zinc alloy or stainless steel.

Surface Wall-Mounted - Surface wall-mounted units shall be 13-1/4 inches wide, 13 inches deep, 10 inches high, and have a back height of 6 to 8 inches. The bowl shall be made of corrosion-resisting steel. The unit shall have concealed fasteners and be for [interior] [exterior] installation.

Semi-Recessed Wall-Mounted - Semi-recessed wall-mounted units shall be 14 inches wide, 11 inches deep, 26-5/8 inches high, and have a back height of 13 to 22 inches. The bowl shall be made of corrosion-resisting steel. The unit shall be for [interior] [exterior] installation.

Recessed Wall-Mounted - Recessed wall-mounted units shall be 16-3/4 inches wide, 11 inches deep, 30 inches high, and have a back height of 13 to 22 inches. The bowl shall be made of corrosion-resisting steel. The unit shall be for [interior] [exterior] installation.

Handicapped - Handicapped units shall be surface wall-mounted. The dimensions shall be 15 inches wide, 20 inches deep, with a back height of 6 to 8 inches. The unit shall clear the floor or ground by at least 8 inches. A clear knee space shall exist between the bottom of the bowl and the floor or ground of at least 27 inches and between the front edge of the bowl and the body of the unit of at least 8 inches. A 8 inch wide clear space shall exist on both sides of the unit. The spout height shall be no more than 36 inches above the floor or ground to the outlet. The spout shall be at the front of the unit and direct the water flow in a trajectory that is parallel or nearly parallel to the front of the unit. The bowl shall be 6-1/2 inches high and made of corrosion-resisting steel. The unit shall be for [interior] [exterior] installation.

Interior Free Standing - Free standing units shall be 40 to 41-1/2 inches high, 12 to 18 inches wide, and 12 to 14 inches deep. The bowl shall be made of corrosion-resisting steel. The unit shall be for interior installation.

Exterior Free Standing - Free standing units shall be 36 inches high, and 12 to 18 inches in diameter. The bowl shall be made of stainless steel. The unit shall be for exterior installation.

P-15 WATER COOLER DRINKING FOUNTAINS:

Water cooler drinking fountains shall: be self contained, conform to ARI 1010, use one of the fluorocarbon gases conforming to ARI 700 and ASHRAE 34 which has an Ozone Depletion Potential of less than or equal to 0.05, have a capacity to deliver 8 gph of water at 50 degrees F with an inlet water temperature of 80 degrees F while residing in a room environment of 90 degrees F, and have self-closing valves. Self-closing valves shall have automatic stream regulators, have a flow control capability, have a push button actuation or have a cross-shaped index metal turn handle without a hood. Exposed surfaces of stainless steel shall have No. 4 general polish finish. Spouts shall provide a flow of water at least 4 inches high so as to allow the insertion of a cup or glass under the flow of water.

Surface Wall-Mounted - Surface wall-mounted units shall be 13-1/4 inches wide, 13 inches deep, and have a back height of 6 to 8 inches. The bowl shall be made of stainless steel. The unit shall have concealed fasteners and be for [interior] [exterior] installation.

Semi-Recessed Wall-Mounted - Semi-recessed wall-mounted units shall be 14 inches wide, 11 inches deep, and have a back height of 13 to 22 inches. The bowl shall be made of stainless steel and be for [interior] [exterior] installation.

Recessed Wall-Mounted - Recessed wall-mounted units shall be 16-3/4 inches wide, 11 inches deep, and have a back height 13 to 22 inches.The bowl shall be made of stainless steel and be for [interior] [exterior] installation.

Handicapped - Handicapped units shall be surface wall-mounted. The dimensions shall be 15 inches wide, 20 inches deep, with a back height of 6 to 8 inches. The unit shall clear the floor or ground by at least 8 inches. A clear knee space shall exist between the bottom of the bowl and the floor or ground of at least 27 inches and between the front edge of the bowl and the body of the unit of at least 8 inches. A 8 inch wide clear space shall exist on both sides of the unit. The spout height shall be no more than 36 inches above the floor or ground to the outlet. The spout shall be at the front of the unit and direct the water flow in a trajectory that is parallel or nearly parallel to the front of the unit. The bowl shall be 6-1/2 inches high, made of stainless steel and be for [interior] [exterior] installation.

Interior Free Standing - Free standing units shall be 40 to 41-1/2 inches high, 12 to 18 inches wide, and 12 to 14 inches deep. The bowl shall be made of stainless steel and be for interior installation.

P-16 FOOD WASTE DISPOSER:

Food waste disposers shall be in accordance with UL 430.

P-17 GARBAGE DISPOSAL MACHINES:

Garbage disposals machines shall be in accordance with CID A-A-50012.

P-18 WASH FOUNTAIN:

[Circular - 6 or 8 station] [Semicircular - 3, 4, 5 station] [Corner, 2 or 3 station], [14 gauge stainless steel] [galvanized steel] [masonry] bowl.

P-19 DISHWASHING MACHINES:

[Commercial dishwashing machines shall conform to NSF 3, NSF 5 and UL 921.]

[Household dishwashing machines shall conform to UL 749 and ASSE 1006, sized as indicated.]

3.11 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

3.12 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, overall efficiency.

ET = Thermal efficiency with 70 degrees F delta T.

EC = Combustion efficiency, 100 percent - flue loss when smoke = o (trace is permitted).

SL = Standby loss in W/sq. ft. based on 80 degrees F delta T, or in percent per hour based on nominal 90 degrees F delta T.

HL = Heat loss of tank surface area.

V = Storage volume in liters

3.12.1 Storage Water Heaters

3.12.1.1 Electric

a. Storage capacity of 120 gallons or less, and input rating of 12 kW or less: minimum energy factor (EF) shall be 0.95-0.00132V per 10 CFR 430.

b. Storage capacity of more than 120 gallons or input rating more than 12 kW: maximum SL shall be 1.9 W/sq. ft. per ASHRAE 90.1, Addenda B.

3.12.1.2 Gas

a. Storage capacity of 100 gallons or less, and input rating of 75,000 Btu/h or less: minimum EF shall be 0.62-0.0019V per 10 CFR 430.

b. Storage capacity of more than 100 gallons - or input rating more than 75,000 Btu/h: Et shall be 77 percent; maximum SL shall be 1.3+38/V, per ANSI Z21.10.3.

3.12.1.3 Oil

a. Storage capacity of 50 gallons or less and input rating of 105,000 Btu/h or less: minimum EF shall be 0.59-0.0019V per 10

CFR 430.

b. Storage capacity of more than 50 gallons or input rating more than 105,000 Btu/h: EC shall be 83 percent; maximum SL shall be 1.3+38/V, per 10 CFR 430.

3.12.2 Unfired Hot Water Storage

Volumes and inputs: maximum HL shall be 6.5 Btu/h/sq. ft.

3.12.3 Instantaneous Water Heater

3.12.3.1 Gas

Volumes and inputs: ET shall be 80 percent per ANSI Z21.10.3.

3.12.3.2 Oil

Capacities and inputs: EC shall be 83 percent per ANSI Z21.10.3.

3.12.4 Pool Heaters

Gas/oil fuel, capacities and inputs: ET shall be 78 percent per ANSI Z21.56.

3.13 TABLES

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

		SERVICE					
Item #	Pipe and Fitting Materials	A	B	C	D	E	F
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A 74 with compression gaskets	X	X	X	X	X	
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A 888		X	X	X		
3	Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 10	X		X	X		
4	Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 10				X	X	
5	Grooved pipe couplings, ferrous and non-ferrous pipe ASTM A 536 and ASTM A 47, ASTM A 47M	X	X		X	X	
6	Ductile iron grooved joint fittings for ferrous pipe ASTM A 536 and ASTM A 47, ASTM A 47M for use with Item 5	X	X		X	X	
7	Bronze sand casting grooved joint pressure fittings for non-ferrous pipe ASTM B 584, for use with Item 5	X	X		X	X	
8	Wrought copper grooved joint pressure pressure fittings for non-ferrous pipe ASTM B 75 C12200, ASTM B 152, ASTM B 152M, C11000, ASME B16.22 ASME B16.22 for use with Item 5	X	X				
9	Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 10				X	X	
10	Steel pipe, seamless galvanized, ASTM A 53, Type S, Grade B	X			X	X	
11	Seamless red brass pipe, ASTM B 43		X	X			
12	Bronzed flanged fittings, ASME B16.24 for use with Items 11 and 14				X	X	

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE A	B	C	D	E	F
13	Cast copper alloy solder joint pressure fittings, ASME B16.18 for use with Item 14				X	X	
14	Seamless copper pipe, ASTM B 42				X		
15	Cast bronze threaded fittings, ASME B16.15				X	X	
16	Copper drainage tube, (DWV), ASTM B 306	X*	X	X*	X	X	
17	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X	X	
18	Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23	X	X	X	X	X	
19	Acrylonitrile-Butadiene-Styrene (ABS) plastic drain, waste, and vent pipe and fittings ASTM D 2661, ASTM F 628	X	X	X	X	X	X
20	Polyvinyl Chloride plastic drain, waste and vent pipe and fittings, ASTM D 2665, ASTM F 891, (Sch 40) ASTM F 1760	X	X	X	X	X	X
21	Process glass pipe and fittings, ASTM C 1053						X
22	High-silicon content cast iron pipe and fittings (hub and spigot, and mechanical joint), ASTM A 518, ASTM A 518M		X			X	
23	Polypropylene (PP) waste pipe and fittings, ASTM D 4101						X
24	Filament-wound reinforced thermosetting resin (RTRP) pipe, ASTM D 2996						X

SERVICE:

A - Underground Building Soil, Waste and Storm Drain
B - Aboveground Soil, Waste, Drain In Buildings
C - Underground Vent
D - Aboveground Vent

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

		SERVICE					
Item #	Pipe and Fitting Materials	A	B	C	D	E	F

E - Interior Rainwater Conductors Aboveground
F - Corrosive Waste And Vent Above And Belowground
* - Hard Temper

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	A	B	C	D
		SERVICE			
1	Malleable-iron threaded fittings, a. Galvanized, ASME B16.3 for use with Item 4a	X	X	X	X
	b. Same as "a" but not galvanized for use with Item 4b			X	
2	Grooved pipe couplings, ferrous pipe ASTM A 536 and ASTM A 47, ASTM A 47M, non-ferrous pipe, ASTM A 536 and ASTM A 47, ASTM A 47M	X	X	X	
3	Ductile iron grooved joint fittings for ferrous pipe ASTM A 536 and ASTM A 47, ASTM A 47M for use with Item 2	X	X	X	
4	Steel pipe: a. Seamless, galvanized, ASTM A 53, Type S, Grade B	X	X	X	X
	b. Seamless, black, ASTM A 53, Type S, Grade B			X	
5	Seamless red brass pipe, ASTM B 43	X	X		X
6	Bronze flanged fittings, ASME B16.24 for use with Items 5 and 7	X	X		X
7	Seamless copper pipe, ASTM B 42	X	X		X
8	Seamless copper water tube, ASTM B 88, ASTM B 88M	X**	X**	X**	X***
9	Seamless and welded copper distribution tube (Type D) ASTM B 641	X**	X**	X**	X****
10	Cast bronze threaded fittings, ASME B16.15 for use with Items 5 and 7	X	X		X
11	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 5 and 7	X	X	X	X

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE A	B	C	D
12	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Items 8 and 9	X	X	X	X
13	Bronze and sand castings grooved joint pressure fittings for non-ferrous pipe ASTM B 584, for use with Item 2	X	X	X	
14	Polyethylene (PE) plastic pipe, Schedules 40 and 80, based on outside diameter ASTM D 2447	X			X
15	Polyethylene (PE) plastic pipe (SDR-PR), based on controlled outside diameter, ASTM D 3035	X			X
16	Polyethylene (PE) plastic pipe (SIDR-PR), based on controlled inside diameter, ASTM D 2239	X			X
17	Butt fusion polyethylene (PE) plastic pipe fittings, ASTM D 3261 for use with Items 14, 15, and 16	X			X
18	Socket-type polyethylene fittings for outside diameter-controlled polyethylene pipe, ASTM D 2683 for use with Item 15	X			X
19	Polyethylene (PE) plastic tubing, ASTM D 2737	X			X
20	Chlorinated polyvinyl chloride (CPVC) plastic hot and cold water distribution system, ASTM D 2846/D 2846M	X	X		X
21	Chlorinated polyvinyl chloride (CPVC) plastic pipe, Schedule 40 and 80, ASTM F 441/F 441M	X	X		X
22	Chlorinated polyvinyl chloride (CPVC) plastic pipe (SDR-PR) ASTM F 442/F 442M	X	X		X

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE A	B	C	D
23	Threaded chlorinated polyvinyl chloride (chloride CPVC) plastic pipe fittings, Schedule 80, ASTM F 437, for use with Items 20, and 21	X	X		X
24	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings, Schedule 40, ASTM F 438 for use with Items 20, 21, and 22	X	X		X
25	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings Schedule 80, ASTM F 439 for use with Items 20, 21, and 22	X	X		X
26	Polyvinyl chloride (PVC) plastic pipe, Schedules 40, 80, and 120, ASTM D 1785	X			X
27	Polyvinyl chloride (PVC) pressure-rated pipe (SDR Series), ASTM D 2241	X			X
28	Polyvinyl chloride (PVC) plastic pipe fittings, Schedule 40, ASTM D 2466	X			X
29	Socket-type polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2467 for use with Items 26 and 27	X			X
30	Threaded polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2464	X			X
31	Joints for IPS pvs pipe using solvent cement, ASTM D 2672	X			X
32	Filament-wound reinforced thermosetting resin (RTRP) pipe, ASTM D 2996	X	X		
33	Steel pipeline flanges, MSS SP-44	X	X		
34	Fittings: brass or bronze; ASME B16.15, and ASME B16.18	X	X		

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE A	B	C	D
	ASTM B 828				
35	Carbon steel pipe unions, socket-welding and threaded, MSS SP-83	X	X	X	
36	Malleable-iron threaded pipe unions ASME B16.39	X	X		
37	Nipples, pipe threaded ASTM A 733	X	X	X	

A - Cold Water Aboveground
B - Hot Water 180 degrees F Maximum Aboveground
C - Compressed Air Lubricated
D - Cold Water Service Belowground
Indicated types are minimum wall thicknesses.
** - Type L - Hard
*** - Type K - Hard temper with brazed joints only or type K-soft temper without joints in or under floors
**** - In or under slab floors only brazed joints

TABLE III
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

A. STORAGE WATER HEATERS

FUEL	STORAGE CAPACITY GALLONS		INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE
Elect.	120 max.		12 kW max.	10 CFR 430	EF = 0.95-0.00132V minimum
Elect.	120 min.	OR	12 kW min.	ASHRAE 90.1 (Addenda B)	SL = 1.9 W/sq. ft. maximum
Gas	100 max.		75,000 Btu/h max.	10 CFR 430	EF = 0.62-0.0019V minimum
Gas	100 min.	OR	75,000 Btu/h	ANSI Z21.10.3	ET = 77 percent; SL = 1.3+38/V max.
Oil	50 max.		105,000 Btu/h	10 CFR 430	EF = 0.59-0.0019V minimum
Oil	51 min.	OR	105,000 Btu/h	10 CFR 430	EC = 83 percent; SL = 1.3+38/V maximum

B. Unfired Hot Water Storage, instantaneous water heater, and pool heater.

Volumes and inputs: maximum HL shall be 6.5 Btu/h/sq. ft.

C. Instantaneous Water Heater

Gas	All	All	ANSI Z21.10.3	ET = 80 percent
Oil	All	All	ANSI Z21.10.3	EC = 83 percent

D. Pool Heater

Gas or Oil	All	All	ANSI Z21.56	ET = 78 percent

TERMS:

EF = Energy factor, overall efficiency.
ET = Thermal efficiency with 70 degrees F delta T.
EC = Combustion efficiency, 100 percent - flue loss when smoke = 0 (trace is permitted).
SL = Standby loss in W/sq. ft. based on 80 degrees F delta T, or in percent per hour based on nominal 90 degrees F delta T.
HL = Heat loss of tank surface area
V = Storage volume in gallons

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-15556 (January 1990)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**
Superseding
CEGS-15556 (July 1989)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 15556

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01/90

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DEPARTMENT OF THE ARMY | **CEGS-15556 (January 1990)**
U.S. ARMY CORPS OF ENGINEERS | **------------------------**
Superseding
CEGS-15556 (July 1989)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 14 (September 1999)
Includes Special Change (Tailoring Options) (July 1998)
Includes Text Adjustment (Section References) (December 1998)

Latest change indicated by CHG tags

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SECTION 15556

FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS
01/90

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NOTE: This guide specification covers the requirements for forced hot water heating system using a steam or high temperature water heat exchanger. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for low temperature systems, steam systems, and high and medium temperature systems. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designations only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990; R 1995) Ferritic Malleable Iron Castings
ASTM A 47M	(1990; R 1996) Ferritic Malleable Iron Castings (Metric)
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 105/A 105M	(1998) Carbon Steel Forgings for Piping Applications
ASTM A 106	(1997a) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 183	(1983; R 1998) Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	(1998) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 234/A 234M	(1997) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A 366/A 366M	(1997) Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
ASTM A 515/A 515M	(1997) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A 516/A 516M	(1990; R 1996) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 569/A 569M	(1997) Commercial Steel (CS) Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled
ASTM A 653/A 653M	(1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B 32	(1996) Solder Metal
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1997) Seamless Copper Tube
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 88M	(1996) Seamless Copper Water Tube (Metric)
ASTM B 251	(1997) General Requirements for Wrought Seamless Copper and Copper-Alloy Tube
ASTM B 265	(1998) Titanium and Titanium Alloy Strip, Sheet, and Plate
ASTM B 333	(1998) Nickel-Molybdenum Alloy Plate, Sheet, and Strip
ASTM B 395	(1995) U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes
ASTM B 395M	(1995) U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes (Metric)
ASTM B 424	(1998) Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825 and UNS N08221) Plate, Sheet, and Strip
ASTM B 650	(1995) Electrodeposited Engineering Chromium Coatings of Ferrous Substrates
ASTM B 687	(1996) Brass, Copper, and Chromium-Plated Pipe Nipples
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM B 828	(1998) Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM D 596	(1991; R 1995) Reporting Results of Analysis of Water
ASTM D 1248	(1984, R 1989) Polyethylene Plastics Molding and Extrusion Materials
ASTM D 1384	(1997a) Corrosion Test for Engine Coolants in Glassware
ASTM D 2000	(1998a) Rubber Products in Automotive Applications

ASTM D 3308	(1997) PTFE Resin Skived Tape

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Gray Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.15	(1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995; B16.22a) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(1997) Valves - Flanged, Threaded, and Welding End
ASME B16.39	(1986; R 1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.1	(1998) Power Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(1997) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(1998; 7th Edition) EJMA Standards

HYDRONICS INSTITUTE (HYI)

HYI-01	(1998) I=B=R Ratings for Boilers, Baseboard Radiation and Finned Tube (Commercial) Radiation

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

NATIONAL ASSOCIATION OF PLUMBING-HEATING-COOLING CONTRACTORS (NAPHCC)

NAPHCC Plumbing Code	(1996) National Standard Plumbing Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item

should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts; [_____].

Spare parts data for each different item of material and equipment specified , after approval of the related submittals and not later than [_____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

Welding Procedures and Qualifications; [_____].

[_____] copies of qualified procedures and list of names and identification symbols of qualified welders and welding operators, prior to welding operations.

SD-04 Drawings

Heating System; [_____].

Detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Drawings shall also contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-06 Instructions

Framed Instructions; [FIO].

Proposed diagrams, instructions, and other sheets, prior to posting. The instructions shall show wiring and control diagrams and complete layout of the entire system. The instructions shall include, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system.

SD-09 Reports

Performance Tests; [_____].

Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

Water Treatment Tests; [_____].

The water quality test report shall identify the chemical composition of the heating water. The report shall include a comparison of the condition of the water with the chemical company's recommended conditions. Any required corrective action shall be documented within the report.

SD-13 Certificates

Bolts; [_____].

Written certification that the bolts furnished comply with the requirements of this specification, provided by the bolt manufacturer. The certification shall include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

SD-19 Operation and Maintenance Manuals

Heating System; FIO.

[Six] [_____] copies of operation and [six] [_____] copies of maintenance manuals for the equipment furnished. One complete set, prior to performance testing and the remainder upon acceptance. Operating manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, water treatment procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Manuals shall be provided prior to the field training course.

1.3 QUALIFICATIONS

Procedures and welders shall be qualified in accordance with the code under which the welding is specified to be accomplished.

1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

PART 2 PRODUCTS

****

NOTE: This guide specification covers low

temperature forced hot water heating systems using water temperatures of 99 degrees C (210 degrees F) and less, at a working pressure of 207 kPa (30 psig) using a steam or high temperature water heat exchanger. A steam supply pressure of approximately 689 kPa (100 psig) and a high water temperature of 177 to 232 degrees C (350 to 450 degrees F) were used in preparation of this specification. The high temperature water portion of this specification may be used for medium water temperature system of 121 to 177 degrees C (250 to 350 degrees F) if the tests and class of valves, fittings, and piping are adjusted for the temperature and pressure required, but not less than 68 kg (150 pound) class system. The designer should consider all pressure reductions such as pump suction and system cool-down effects and should not consider any pressure increases such as pump discharge heads and system heat-up effects when determining the high or medium temperature water system pressurization required to prevent flash steaming and water hammer.
****

2.1 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

2.1.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.3 Equipment Guards and Access

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified. [Catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed in accordance with Section 05500 MISCELLANEOUS METAL.]

2.1.4 Asbestos Prohibition

Asbestos and asbestos-containing products shall not be used.

2.1.5 Electrical Work

****
NOTE: Select standard efficiency for motors used less than 750 hours per year and high efficiency for motors used over 750 hours per year.
****

Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electric equipment (including motor efficiencies), and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. [Standard] [High efficiency] motors shall be used. Electrical characteristics shall be as specified or indicated. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control specified. Each motor shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring, conduit, and connection to power required for controls and devices but not shown shall be provided.

2.2 PIPING, TUBING, AND FITTINGS

****
NOTE: Copper tubing and steel pipe will be considered as competitive unless one is not applicable for service.
****

2.2.1 General

Piping, tubing, and fittings shall be as follows:

a. Low temperature water piping shall be black steel or copper tubing with cast iron, malleable iron or steel, solder-joint, flared-tube or grooved mechanical joint fittings.

b. Steam pipe shall be black steel with malleable iron or steel fittings.

c. Condensate return piping shall be black steel Schedule 80 with cast iron or malleable iron, Class 250 minimum.

d. High temperature water piping shall be black steel, Schedule 40.

e. Vent piping shall be black steel, Schedule 40, with black malleable iron fittings.

2.2.2 Steel Pipe

Pipe shall conform to ASTM A 53 or ASTM A 106, Grade A or B, black steel, Schedule 40, unless otherwise specified. Steel pipe to be bent shall be ASTM A 53, Grade A, standard, or Grade B, extra strong weight. Steam pipe shall be ASTM A 53 Grade A.

2.2.3 High Temperature Water Piping

Piping shall be Type S for 1-1/2 inches and smaller, Type S or Type E for pipe 2 inches and larger, schedule 40 steel conforming to ASTM A 53, Grade B; or to ASTM A 106, Grade B.

2.2.4   Gauge Piping

Piping shall be copper tubing for [steam] [and] [low temperature water]. [Black steel, ASTM A 106, seamless, Grade A pipe shall be used for high temperature.]

2.2.5   Copper Tubing

Tubing shall conform to ASTM B 88, ASTM B 88M, Type K or L. Tubing for compressed air tubing shall conform to ASTM B 251.

2.2.6   High Temperature Water Fittings

Fittings shall be steel welding fittings conforming in physical and chemical properties to ASTM A 234/A 234M. Buttwelding fittings shall conform to ASME B16.9. Socket welded fittings shall conform to ASME B16.1. Screwed fittings, when required, shall be black forged steel, 2000-pound class, conforming to ASME B16.11. Flanges shall be serrated or raised-faced type.

2.2.7   Malleable Iron Pipe Fittings

Fittings shall conform to ASME B16.3, type required to match adjacent piping.

2.2.8   Cast Iron Pipe Fittings

Fittings shall conform to ASME B16.1 or ASME B16.4 type required to match adjacent piping.

2.2.9   Steel Pipe Fittings

Fittings shall have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

2.2.9.1   Welded Fittings

Welded fittings shall conform to ASTM A 234/A 234M with WPA marking. Butt welded fittings shall conform to ASME B16.9, and socket welded fittings shall conform to ASME B16.11.

2.2.9.2   Grooved Mechanical Fittings

Standard fittings shall be of malleable iron conforming to ASTM A 47, ASTM A 47M, Grade 32510, or ductile iron conforming to ASTM A 536, Grade 65-45-12. Fittings may also be constructed of steel, conforming to ASTM A 106, Grade B or ASTM A 53.

2.2.9.3   Grooved Mechanical Pipe Joints

****

NOTE: Gasket material must be specified: EPDM for temperatures to 110 degrees C (230 degrees F); Buna-N for temperatures to 82 degrees C (180 degrees F). Review manufacturer's data for other requirements and limits. Do not use for steam.

****

Pipe joints shall conform to AWWA C606. Grooved mechanical joint fittings shall be full flow factory manufactured forged steel fittings. Fittings, couplings, gaskets, and pipe grooving tool or grooved end pipe shall be products of the same manufacturer. Mechanical pipe couplings shall be of the bolted type and shall consist of a housing fabricated in two or more parts, a synthetic rubber gasket, and nuts and bolts to secure unit together. Housings shall be of malleable iron conforming to ASTM A 47, ASTM A 47M, Grade 32510 or ductile iron conforming to ASTM A 536, Grade 65-45-12. Coupling nuts and bolts shall be of steel and conform to ASTM A 183. Gaskets shall be of molded synthetic rubber, Type [EPDM] [Buna-N] with central cavity, pressure responsive configuration and shall conform to ASTM D 2000.

2.2.10 Fittings for Copper Tubing

Wrought copper and bronze fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy fittings shall conform to ASME B16.18 and ASTM B 828. Flared fittings shall conform to ASME B16.26 and ASTM B 62. Adaptors may be used for connecting tubing to flanges and threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used. Cast bronze threaded fittings shall conform to ASME B16.15.

2.2.11 Steel Flanges

Flanged fittings including flanges, bolts, nuts, bolt patterns., etc. shall be in accordance with ASME B16.5 class 150 and shall have the manufacturers trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105/A 105M. Flanges for high temperature water systems shall be serrated or raised-face type. Blind flange material shall conform to ASTM A 516/A 516M cold service and ASTM A 515/A 515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193/A 193M.

2.2.12 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

2.2.13 Nipples

Nipples shall conform to ASTM A 733 or ASTM B 687, standard weight.

2.2.14 Unions

Unions shall conform to ASME B16.39, type to match adjacent piping.

2.2.15 Adapters

Adapters for copper tubing shall be brass or bronze for soldered fittings.

2.2.16 Dielectric Unions

Unions shall conform to the tensile strength and dimensional requirements specified in ASME B16.39. Unions shall have metal connections on both ends to match adjacent piping. Metal parts of dielectric unions shall be separated so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact.

2.2.17 Grooved Mechanical Joints

Rigid grooved pipe joints may be provided in lieu of unions, welded, flanges or screwed piping connections at chilled water pumps and allied equipment, and on aboveground pipelines in serviceable locations, if the temperature of the circulating medium does not exceed 230 degrees F. Flexible grooved joints will not be permitted, except as vibration isolators adjacent to mechanical equipment. Rigid grooved joints shall incorporate an angle bolt pad design which maintains metal-to-metal contact with equal amount of pad offset of housings upon installation to insure positive rigid clamping of the pipe. Designs which can only clamp on the bottom of the groove or which utilize gripping teeth or jaws, or which use misaligned housing bolt holes, or which require a torque wrench or torque specifications, will not be permitted. Rigid grooved pipe couplings shall be used with grooved end pipes, fittings, valves and strainers. Rigid couplings shall be designed for not less than 125 psi service and appropriate for static head plus the pumping head, and shall provide a water-tight joint. Grooved fittings and couplings, and grooving tools shall be provided from the same manufacturer. Segmentally welded elbows shall not be used. Grooves shall be prepared in accordance with the coupling manufacturer's latest published standards. Grooving shall be performed by qualified grooving operators having demonstrated proper grooving procedures in accordance with the tool manufacturer's recommendations. The Contracting Officer shall be notified 24 hours in advance of test to demonstrate operator's capability, and the test shall be performed at the work site, if practical, or at a site agreed upon. The operator shall demonstrate the ability to properly adjust the grooving tool, groove the pipe, and verify the groove dimensions in accordance with the coupling manufacturer's specifications.

2.2.18 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 125 psi or 150 psi service as appropriate for the static head plus the system head, and 250 degrees F. Connectors shall be installed where indicated. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. Materials used and the configuration shall be suitable for the pressure, vacuum, temperature, and circulating medium. The flexible section may have threaded, welded, soldered, flanged, grooved, or socket ends. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

2.3 MATERIALS AND ACCESSORIES

2.3.1 Iron and Steel Sheets

2.3.1.1 Galvanized Iron and Steel

Galvanized iron and steel shall conform to ASTM A 653/A 653M, with general requirements conforming to ASTM A 653/A 653M. Gauge numbers specified are Manufacturer's Standard Gauge.

2.3.1.2 Uncoated (Black) Steel

Uncoated (black) steel shall conform to ASTM A 366/A 366M or ASTM A 569/A

569M, composition, condition, and finish best suited to the intended use. Gauge numbers specified refer to Manufacturer's Standard Gauge.

2.3.2 Solder

Solder shall conform to ASTM B 32. Solder and flux shall be lead free. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B 813.

2.3.3 Solder, Silver

Silver solder shall conform to AWS A5.8.

2.3.4 Thermometers

Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 9 inch scale, and thermometers shall have rigid stems with straight, angular, or inclined pattern.

2.3.5 Gauges

Gauges shall conform to ASME B40.1.

2.3.6 Gaskets for Flanges

Composition gaskets shall conform to ASME B16.21. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. Gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service. Gaskets shall be suitable for pressure and temperatures of piping system.

2.3.7 Polyethylene Tubing

Low-density virgin polyethylene shall conform to ASTM D 1248, Type I, Category 5, Class B or C.

2.3.8 Bellows-Type Joints

****

NOTE: Select bellows-type or slip-type to satisfy specific design conditions.

****

Joints shall be flexible, guided expansion joints. Expansion element shall be of stainless steel. Bellows-type expansion joints shall be in accordance with the applicable requirements of EJMA Stds and ASME B31.1 with internal liners.

2.3.9 Expansion Joints

Expansion joints shall provide for either single or double slip of connected pipes, as required or indicated, and for not less than the traverse indicated. Joints shall be designed for hot water working pressure not less than [_____] psig and shall be in accordance with applicable requirements of EJMA Stds and ASME B31.1. Joints shall be designed for packing injection under full line pressure. End connections shall be flanged or beveled for welding as indicated. Joints shall be provided with anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip shall be seamless steel plated with a minimum of 2 mils of hard chrome conforming to ASTM B 650. Joint components shall be fabricated from material equivalent to that of the pipeline. Initial settings shall be made in accordance with manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by joint manufacturer, but in any case shall not be more than 5 feet from expansion joint except for lines 4 inches or smaller, guides shall be installed not more than 2 feet from the joint. Service outlets shall be provided where indicated.

2.3.10 Flexible Ball Joints

Flexible ball joints shall be constructed of alloys as appropriate for the service intended. Where so indicated, the ball joint shall be designed for packing injection under full line pressure to contain leakage. Joint ends shall be threaded (to 2 inches only), grooved, flanged or beveled for welding as indicated or required and shall be capable of absorbing a minimum of 15-degree angular flex and 360-degree rotation. Balls and sockets shall be of equivalent material as the adjoining pipeline. Exterior spherical surface of carbon steel balls shall be plated with 2 mils of hard chrome conforming to ASTM B 650. Ball type joints shall be designed and constructed in accordance with ASME B31.1 and ASME BPV VIII Div 1, where applicable. Flanges where required shall conform to ASME B16.5. Gaskets and compression seals shall be compatible with the service intended.

2.3.11 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.4 VALVES FOR LOW TEMPERATURE WATER HEATING AND STEAM SYSTEMS

****

NOTE: Valves apply to low temperature water heating or low pressure steam systems. Delete for high or medium temperature water systems.

****

2.4.1 Check Valves

****

NOTE: Indicate the type of valves, vertical lift or horizontal, on the drawings.

****

Sizes 2-1/2 inches and less, bronze shall conform to MSS SP-80, Type 3 or 4, Class 125. Sizes 3 inches through 24 inches, cast iron shall conform to MSS SP-71, Type III or IV, Class 125.

2.4.2 Globe Valves

Sizes 2-1/2 inches and less, bronze shall conform to MSS SP-80, Type 1, 2 or 3, Class 125. Sizes 3 inches through 12 inches, cast iron shall conform to MSS SP-85, Type III, Class 125.

2.4.3 Angle Valves

Sizes 2-1/2 inches and less, bronze shall conform to MSS SP-80, Type 1, 2 or 3, Class 125. Sizes 3 inches through 12 inches, cast iron shall conform to MSS SP-85, Type III, Class 125.

2.4.4 Gate Valves

Sizes 2-1/2 inches and less, bronze shall conform to MSS SP-80, Type 1 or 2, Class 125. Sizes 3 inches through 48 inches, cast iron shall conform to MSS SP-70, Type I, Class 125, Design OT or OF (OS&Y), bronze trim.

2.4.5 Air Vents

****

NOTE: Air vent locations will be indicated on drawings; distinguish between manual vents and automatic air vents.

****

Air vents shall be provided at all piping high points in water systems, with block valve in inlet and internal check valve to allow air vent to be isolated for cleaning and inspection. Outlet connection shall be piped to nearest open site or suitable drain, or terminated 12 inches above finished grade. Pressure rating of air vent shall match pressure rating of piping system. Body and cover shall be cast iron or semi-steel with stainless steel or copper float and stainless steel or bronze internal parts. Air vents installed in piping in chase walls or other inaccessible places shall be provided with an access panel.

2.4.6 Balancing Valves

Balancing valves shall have meter connections with positive shutoff valves. An integral pointer shall register degree of valve opening. Valves shall be calibrated so that flow in gpm can be determined when valve opening in degrees and pressure differential across valve is known. Each balancing valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation. Valves shall be suitable for 250 degrees F temperature and working pressure of the pipe in which installed. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. One portable differential meter shall be furnished. The meter suitable for the operating pressure specified shall be complete with hoses, vent, and shutoff valves and carrying case. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing. Plug valves and ball valves 8 inches or larger shall be provided with manual gear operators with position indicators.

2.4.7 Automatic Flow Control Valves

****

NOTE: In any facility where technological and occupancy requirements indicate that load imbalances cannot be tolerated and there is a need for automatic control ensuring constant hydronic flow,

the design will incorporate automatic flow control valves indicating there location and capacity on the drawings.
****

The valves shall be designed to be sensitive to pressure differential across the valve to provide the required opening. The valves shall be selected for the flow required and provided with a permanent nameplate or tag carrying a record of the factory-determined flow rate and flow control pressure levels. Valves shall control the flow within 5 percent of the tag rating. Valves shall be suitable for the maximum operating pressure of 125 psi or 150 percent of the system operating pressure, whichever is greater. [Where the available system pressure is not adequate to provide the minimum pressure differential that still allows flow control, the system pump head shall be increased.] Valves shall be suitable for the maximum system operating temperature and pressure. Valve materials shall be same as specified for low temperature heating system check, globe, angle and gate valves. Valve operator shall be the electric motor type or pneumatic type as applicable. Valve operator shall be capable of positive shutoff against the system pump head.

2.4.8 Gravity Flow Control Valves

Ends shall be soldered, threaded, or flanged type as applicable, and designed for easy cleaning without disconnecting piping. Valves for copper tubing shall be bronze. Valves shall prevent flow due to gravity when circulators are off.

2.4.9 Radiator Valves

Automatic thermostatic radiator valves shall be self-contained [direct sensor] [remote sensor] [wall thermostat] controlled nonelectric temperature control valves. Valve bodies shall be constructed of chrome plated brass and shall be angle or straight pattern as indicated, with threaded or brazed end connections. Valve disc shall be of ethylene propylene or composition material. Thermostatic operators shall be a modulating type consisting of a sensing unit counter balanced by a spring setting.

2.5 VALVES FOR HIGH AND MEDIUM TEMPERATURE WATER SYSTEMS

****
NOTE: Valves apply to high and medium temperature water systems and high pressure steam systems. Delete for low temperature water heating systems or low pressure steam systems.
****

2.5.1 Check Valves

****
NOTE: Indicate the type of valves, vertical lift or horizontal, on the drawings.
****

Sizes 2-1/2 inches and less, bronze shall conform to MSS SP-80, Class 300
Sizes 2-1/2 inches and less, bronze shall conform to MSS SP-80, Class 300
minimum. Sizes 3 inches through 24 inches, steel shall conform to ASME

B16.34, Class 300 minimum, flanged ends, swing disc; water, oil gas or steam service to 850 degrees F.

2.5.2 Globe Valves

Sizes 2-1/2 inches and less, bronze shall conform to MSS SP-80, Type 1, 2 or 3, Class 300 minimum. Sizes 3 inches through 24 inches, steel shall conform to ASME B16.34, Class 300 minimum, flanged ends; water, oil, gas, or steam service to 850 degrees F.

2.5.3 Angle Valves

Sizes 2-1/2 inches and less, bronze shall conform to MSS SP-80, Type 1, 2 or 3, Class 300 minimum. Sizes 3 inches through 24 inches, steel shall conform to ASME B16.34, Class 300 minimum, flanged ends; water, oil, gas, or steam service to 850 degrees F.

2.5.4 Gate Valves

Sizes 2-1/2 inches and less, bronze shall conform to MSS SP-80, Type 1, or 2, Class 300 minimum. Sizes 3 inchesthrough 24 inches, steel shall conform to ASME B16.34, Class 300 minimum, flanged ends; water, oil, gas or steam service to 850 degrees F. Gate shall be split wedge (double disc) type.

2.6 COLD WATER CONNECTIONS

Connections shall be provided which include consecutively in line a strainer, backflow prevention device, and water pressure regulator. The backflow prevention device shall be provided as indicated and in compliance with Section 15400 PLUMBING, GENERAL PURPOSE.

2.6.1 Strainers

Basket or Y-type strainers shall be the same size as the pipelines in which they are installed. Strainer bodies shall be rated for [125] [250] pound service, with bottoms drilled and plugged. Bodies shall have arrows cast on the sides to indicate the direction of flow. Each strainer shall be equipped with a removable cover and sediment basket. Basket shall not be less than 22 gauge and shall have perforations to provide a net free area through the basket of at least four times that of the entering pipe.

2.6.2 Pressure Regulating Valve

Valve shall be a type that will not stick nor allow pressure to build up on the low side. Valve shall be set to maintain a terminal pressure approximately 5 psi in excess of the static head on the system and shall operate within a 20 psi variation regardless of initial pressure and without objectionable noise under any condition of operation.

2.7 FLASH TANK

Tank shall be sized and installed as indicated, and shall be of welded construction utilizing black steel sheets not less than 11 gauge. Tank shall be provided with a handhole and with tapping for the condensate returns, drip lines, vent line, and condensate discharge line to the condensate receiver. Discharge line shall be equipped with a float trap. Tank shall be ASME rated for [_____] psig in accordance with ASME BPV VIII Div 1.

2.8 EXPANSION TANK

Pressurization system shall include a replaceable diaphragm-type captive air expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank. Sizes shall be as indicated. Expansion tank shall be welded steel, constructed, tested and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of [125] [_____] psig and precharged to the minimum operating pressure. Tank air chamber shall be fitted with an air charging valve. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations.

2.9 AIR SEPARATOR TANK

External air separation tank shall be steel, constructed, tested, and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of [125] [_____] psi. The capacity of the air separation tank indicated is minimum.

2.10 STEAM TRAPS

****

NOTE: Applicable to steam systems only. A schedule of steam trap selection will be located on drawings showing trap orifice size, capacity (kg/hr (#/hr)), and pressure drop (kPa (psi)), for each trap required. Delete steam traps not required.

****

2.10.1 Float Traps

Capacity, working pressure, and differential pressure of the traps shall be as indicated.

2.10.2 Float-and-Thermostatic Traps

Traps shall be designed for a steam working pressure of approximately 15 psig, but shall operate with a supply pressure of approximately 5 psig. The capacity of the traps shall be as indicated. Trap capacity shall be based on a pressure differential of 1/4 psi. Each float-and-thermostatic trap shall be provided with a hard bronze, monel, or stainless steel valve seat and mechanism and brass float, all of which can be removed easily for inspection or replacement without disturbing the piping connections. Inlet to each trap shall have a cast iron strainer, either an integral part of the trap or a separate item of equipment.

2.10.3 Bucket Traps

Traps shall be inverted or vertical bucket type with automatic air discharge. Traps shall be designed for a working pressure of 150 psig, but shall operate under a steam supply pressure of approximately 40 to 100 psig as required. Each trap shall have a heavy body and cap of fine-grained, gray cast iron. The bucket shall be made of brass; the mechanism of hard bronze; the valve and seat of stainless or monel; or each of equivalent material. Traps shall be tested hydrostatically under a pressure of 200 psig. Traps shall have capacities as indicated when operating under the specified working conditions. A strainer shall be installed in the suction connection of each trap. Impact operated traps, impulse-operated traps, or thermodynamic traps with continuous discharge may be installed in lieu of bucket traps, subject to approval. Thermostatic traps designed for a steam working pressure suitable for the application may be furnished in lieu of the traps specified above. Thermostatic traps shall be equipped with valves and seats of stainless steel or monel metal, and shall have capacities based on a pressure differential not in excess of the following:

Steam Working Pressure, psi	Differential, psi
25-50	20
90-100	80

2.11 HEAT EXCHANGERS

****

NOTE: The following information applicable to the project will be indicated on the drawings:

a. Capacity of heat exchanger in liters per minute (gpm).

b. Supply and return temperatures of low temperature water in degrees C (degrees F).

c. Supply and return temperatures of high or medium temperature water in degrees C (degrees F).

d. Steam pressure in kPa (psig).

e. Pressure drops in mm (feet) of water or kPa (psig).

f. Fouling allowances for steam or high temperature water and for low temperature water will be determined by the system designer. Recommended allowances are listed in the Tubular Exchanger Manufacturers Association (TEMA) Standards. Insert system fouling allowance in blank space.

****

Heat exchangers shall be multiple pass shell and U-tube type or plate and frame type as indicated, to provide low temperature hot water for the heating system when supplied with [steam] [or] [high temperature hot water] [or] [medium temperature hot water] at the temperatures and pressures indicated. Temperature and pressure for plate and frame exchangers shall not exceed 280 degrees F and 280 psig for medium temperature hot water, or 280 degrees F and 35 psig for steam. Temperature and pressure for shell and U-tube exchangers shall not exceed 338 degrees F and 100 psig for steam or 430 degrees F and 400 psig for high temperature hot water. Exchangers shall be constructed in accordance with ASME BPV VIII Div 1 and certified with ASME stamp secured to unit. U-tube bundles shall be completely removable for cleaning and tube replacement and shall be free to expand with shell. Shells shall be of seamless steel pipe or welded steel construction and tubes shall be seamless tubing as specified below unless otherwise indicated. Tube connections to plates shall be leakproof. Saddles or cradles shall be provided to mount shell and U-tube exchangers. Frames of plate and frame type exchangers shall be fabricated of carbon steel and finished with baked epoxy enamel. Design fouling factor shall be [_____].

2.11.1 Steam Heat Exchangers, Shell and U-Tube Type

Exchangers shall operate with steam in shell and low temperature water in tubes. Shell and tube sides shall be designed for 150 psig working pressure and factory tested at 300 psig. Steam, water, condensate, and vacuum and pressure relief valve connections shall be located in accordance with the manufacturer's standard practice. Connections larger than 3 inches shall be ASME 150 pound flanged. Water pressure loss through clean tubes shall not exceed 6 psi and water velocity shall not exceed 6 fps unless otherwise indicated. Minimum water velocity in tubes shall be not less than 1 fps and assure turbulent flow. Tubes shall be seamless copper or copper alloy, constructed in accordance with ASTM B 75 or ASTM B 395, ASTM B 395M, suitable for the temperatures and pressures specified. Tubes shall be not less than 3/4 inch unless otherwise indicated. Maximum steam inlet nozzle velocity shall not exceed 6000 fpm.

2.11.2 High Temperature Water Heat Exchangers, Shell and U-tube Type

Exchangers shall operate with low temperature water in shell and high temperature water in tubes. Shell side shall be designed for 150 psig working pressure and factory tested at 300 psig. Tubes shall be designed for 400 psig working pressure and an operating temperature of 450 degrees F. High and low temperature water and pressure relief connections shall be located in accordance with the manufacturer's standard practice. Water connections larger than 3 inches shall be ASME 600 pound flanged for high temperature water, and ASME 150 pound flanged for low temperature water. Water pressure loss through clean tubes shall not exceed 6 psig unless otherwise indicated. Minimum water velocity in tubes shall be 1 fps and assure turbulent flow. Tubes shall be cupronickel or inhibited admiralty, constructed in accordance with ASTM B 395, ASTM B 395M, suitable for the temperatures and pressures specified. Tubes shall be not less than 3/4 inch unless otherwise indicated.

2.11.3 Steam Heat Exchangers, Plate and Frame Type

Plates, frames and gaskets shall be designed for a working pressure of 300 psig and factory tested at 450 psig.Steam, low temperature water, condensate, and vacuum and pressure relief valve connections shall be located in accordance with the manufacturer's standard practice. Connections larger than 3 inches shall be ASME 150 pound flanged. Water pressure drop through clean plates and headers shall not exceed [_____] psig at the flow rates and temperatures indicated. Plates shall be designed to assure turbulent flow at a minimum rate of [_____] gpm through any 2 plate segment. Plates shall be corrugated [Type 304 stainless steel] [Type 316 stainless steel] [nickel-iron-chromium alloy conforming to ASTM B 424] [nickel-molybdenum alloy conforming to ASTM B 333] [titanium alloy conforming to ASTM B 265]. Plate thickness shall be not less than [_____] inch.

2.11.4 Medium Temperature Water Heat Exchangers, Plate and Frame Type

Plates, frames and gaskets shall be designed for a working pressure of 300 psig and factory tested at 450 psig.Medium temperature water, low temperature water, and pressure relief valve connections shall be located in accordance with the manufacturer's standard practice. Connections larger than 3 inches shall be ASME 300 poundflanged. Water pressure drop through clean plates and headers shall not exceed [_____] psi at the flow rates and temperatures indicated. Plates shall be designed to assure turbulent flow at a minimum rate of [_____] gpm through any 2 plate segment. Plates shall be corrugated [Type 304 stainless steel] [Type 316 stainless steel] [nickel-iron-chromium alloy conforming to ASTM B 424] [nickel-molybdenum alloy conforming to ASTM B 333] [titanium alloy conforming to ASTM B 265]. Plate thickness shall be not less than [_____] inch.

2.12 SYSTEM EQUIPMENT AND ACCESSORIES

2.12.1 Circulating Pumps

Pumps for hot water shall be of the single-stage centrifugal type, electrically driven. Pumps shall be supported [on a concrete foundation] [or] [by the piping on which installed] [as indicated]. Pumps shall be either integrally mounted with the motor or direct-connected by means of a flexible-shaft coupling on a cast iron, or steel sub-base. Pump housing shall be of close grained cast iron. Shaft shall be carbon or alloy steel, turned and ground. Shaft seal shall be mechanical-seal or stuffing-box type. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Bearings shall be ball-, roller-, or oil-lubricated, bronze-sleeve type, and shall be sealed or isolated to prevent loss of oil or entrance of dirt or water. Motor shall be of a type approved by the manufacturer of the pump.

2.12.2 Condensate Pumping Unit

****

NOTE: Size condensate pumping rate for three times the expected condensate flow. Size receiver for five times the expected condensate flow for expected condensate flow up to 30 liters per minute (8 GPM). Size receiver two times the expected condensate flow for expected condensate flow over 30 liters per minute (8 GPM).

****

Pump shall have a minimum capacity, as indicated, of [_____] gpm when discharging against the specified pressure. The minimum capacity of the tank shall be [_____] gallons. Condensate pumping unit shall be of the [single] [duplex], [horizontal-shaft] [vertical-shaft] type, as indicated. Unit shall consist of [one pump] [two pumps], [one electric motor] [two electric motors] and a single receiver. Pumps shall be centrifugal or turbine type, bronze-fitted throughout with impellers of bronze or other corrosion-resistant metal. Pumps shall be free from air-binding when handling condensate with temperatures up to 200 degrees F. Pumps shall be connected directly to dripproof enclosed motors. Receiver shall be cast iron and shall be provided with condensate return, vent, overflow, and pump suction connections, and water level indicator and automatic air vent. Inlet strainer shall be provided in the inlet line to the tank. Vent pipe shall be galvanized steel, and fittings shall be galvanized malleable iron. Vent pipe shall be installed as indicated or directed. Vent piping shall be flashed as specified. Pump, motor, and receiving tank may be mounted on a single base with the receiver piped to the pumps suctions. A gate valve and check valve shall be provided in the discharge connection from each pump.

2.12.2.1 Controls

Enclosed float switches complete with float mechanisms shall be installed in the head of the receiver. The condensate pump shall be controlled automatically by means of the [respective] float switch that will automatically start the motor when the water in the receiving tank reaches the high level and stop the motor when the water reaches the low level. Motors shall be provided with magnetic across-the-line starters equipped with general purpose enclosure and Automatic-Manual-Off selector switch in the cover.

2.12.2.2 Factory Testing

The Contractor shall submit a certificate of compliance from the pump manufacturer covering the actual test of the unit and certifying that the equipment complies with the indicated requirements.

2.12.3 Pressure Gauges and Thermometers

Gauges shall be provided for each heat exchanger and piping as indicated. A thermometer and pressure gauge shall be provided on the high temperature water supply and return mains. Thermometers shall be separable socket type.

2.12.4 Vacuum Relief Valve

Vacuum relief valve shall be installed on the shell of each shell and U-tube steam heat exchanger and on the factory supplied steam inlet nozzle of each plate and frame heat exchanger. On shutoff of steam supply and condensing of steam, the vacuum relief valve shall automatically admit air to the heat exchanger.

2.12.5 Pressure Relief Valves

One or more pressure relief valves shall be provided for each heat exchanger in accordance with ASME BPV VIII Div 1. The aggregate relieving capacity of the relief valves shall be not less than that required by the above code. Discharge from the valves shall be installed as indicated. Pressure relief valves for steam heat exchangers shall be located on the low temperature water supply coming from near the heat exchanger as indicated. Relief valves for high temperature water heat exchanger shall be installed on the heat exchanger shell.

2.12.6 Drains

****

NOTE: Drawings shall indicate low-point drains.

****

A drain connection with 3/4 inch hose bib shall be installed at the lowest point in the low temperature water return main near the heat exchanger. In addition, threaded drain connections with threaded cap or plug shall be installed wherever required for thorough draining of the low temperature water system.

2.12.7 Strainers

****
NOTE: Select the correct piping and pipe fittings (steam or high-temperature water) and delete the inapplicable system.
****

Basket or Y-type strainer-body connections shall be the same size as the pipe lines in which the connections are installed. The bodies shall have arrows clearly cast on the sides to indicate the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment basket. The body or bottom opening shall be equipped with nipple and gate valve for blowdown. The basket for steam systems shall be of not less than 0.025 inch thick stainless steel, or monel with small perforations of sufficient number to provide a net free area through the basket of at least 2.5 times that of the entering pipe. The flow shall be into the basket and out through the perforations. [For high temperature water systems, only cast steel bodies shall be used.] [The strainer bodies for steam systems shall be of cast steel or gray cast iron with bottoms drilled and plugged.]

2.13 INSULATION

Shop and field applied insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.14 FACTORY PAINTED EXPOSED SPACE HEATING EQUIPMENT

Radiator and convector enclosures shall be coated with the manufacturer's standard rust inhibiting primer for painting in the field as specified in Section 09900 PAINTING, GENERAL. All other exposed heating equipment shall be painted at the factory with the manufacturer's standard primer and enamel finish.

2.15 RADIATORS AND CONVECTORS

****
NOTE: Drawings shall indicate the types, sizes, and capacities of radiators and convectors. Show typical piping details on drawings for radiators and convectors.
****

The radiator and convector shall be the type and size indicated. The supply and return connections shall be the same size. Cast iron radiators and nonferrous convectors shall be tested hydrostatically at the factory and proved tight under a pressure of not less than [_____] psig. A certified report of these tests shall be furnished in accordance with paragraph SUBMITTALS.

2.15.1 Cast Iron Radiators

Cast iron radiators shall be gray cast iron, free from sandholes and other defects. The sections shall be connected with malleable iron nipples not less than 0.09 inch thick at any point. Cast iron radiators shall be the legless type mounted on the walls by means of hangers as specified. Adjustable radiator hangers shall be secured to the wall and shall hold the radiators near both ends, at both top and bottom, is such manner that the radiators cannot be removed without the use of tools. Not less than two bolts shall be used to secure each hanger to the wall. Necessary angles, bolts, bearing plates, toggles, radiator grips, and other parts required for complete installation of the radiators shall be provided.

2.15.2 Extended-Surface, Steel, or Nonferrous Tube-Type Radiators

****

NOTE: The type of cover grille selected for fin-type radiators shall suit the particular building involved.

****

Radiators shall consist of metal fins permanently bonded to steel or nonferrous pipe cores, with threaded or sweat fittings at each end for connecting to external piping. Radiators shall have capacities not less than those indicated, determined in accordance with HYI-01. Radiators shall be equipped with [expanded-metal cover grilles fabricated from black steel sheets not less than 16 gauge, secured either directly to the radiators or to independent brackets.] [solid-front, slotted horizontal-top cover grilles fabricated from black steel sheets not less than 18 gauge, secured either directly to the radiators or to independent brackets.] [solid-front, slotted sloping-top cover grilles fabricated from black steel sheets not less than 16 gauge, independently secured to masonry with brackets.]

2.15.3 Convectors

Convectors shall be constructed of cast iron or of nonferrous alloys, and shall be installed where indicated. Capacity of convectors shall be as indicated. Overall space requirements for convectors shall not be greater than the space provided. Convectors shall be complete with heating elements and enclosing cabinets having bottom recirculating opening, manual control damper and top supply grille. Convector cabinets shall be constructed of black sheet steel not less than 20 gauge.

2.15.4 Radiators and Convectors Control

[The space temperature shall be maintained automatically by regulating water flow to the radiators and convectors by the self contained, automatic thermostatic radiator control valves.] [Controls shall be provided as specified in Section 15950 HEATING, VENTILATING, AND AIR-CONDITIONING HVAC CONTROL SYSTEMS.]

2.16 UNIT HEATERS

****

NOTE: Indicate capacity of unit heaters and heating and ventilating units on drawings. Show typical piping details on drawings for these units.

In critical areas where maximum noise level limits are required, the sentence in brackets will be retained and the brackets deleted. The maximum acceptable noise limits for these critical areas will be determined in NC level or dbA and should be indicated on the drawings. The sentence in brackets will be deleted for noncritical areas. Sound values

will be selected by the designer based on a study of the design goal. The ASHRAE Handbook, Fundamentals, shows the range of sound pressure values for speech communications as being 50 dB for fair, 44 dB for very good, and 38 dB for perfect speech intelligibility.
****

Heaters shall be as specified below, and shall have a heating capacity not in excess of 125 percent of the capacity indicated. [Noise level of each unit heater for areas noted shall not exceed the criteria indicated.]

2.16.1 Propeller Fan Heaters

Heaters shall be designed for suspension and arranged for [horizontal] [vertical] discharge of air as indicated. Casings shall be not less than 20 gauge black steel and finished with lacquer or enamel. Suitable [stationary] [rotating air] deflectors shall be provided to assure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes will not be permitted. [Fans for vertical discharge type heaters shall operate at speeds not in excess of 1,200 rpm, except that units with 80,000 Btu output capacity or less may operate at speeds up to 1,800 rpm.] [Horizontal discharge type unit heaters shall have discharge or face velocities not in excess of the following]:

[Unit Capacity, cfm	Face Velocity, fpm
Up to 1,000	800
1,001 to 3,000	900
3,001 and over	1,000]

2.16.2 Centrifugal Fan Heaters

Heaters shall be arranged for floor or ceiling mounting as indicated. Heating elements and fans shall be housed in steel cabinets of sectionalized steel plates or reinforced with angle-iron frames. Cabinets shall be constructed of not lighter than 18 gauge black steel. Each unit heater shall be provided with a means of diffusing and distributing the air. Fans shall be mounted on a common shaft, with one fan to each air outlet. Fan shaft shall be equipped with self-aligning ball, roller, or sleeve bearings and accessible means of lubrication. Fan shaft may be either directly connected to the driving motor or indirectly connected by adjustable V-belt drive rated at 150 percent of motor capacity. All fans in any one unit heater shall be the same size.

2.16.3 Heating Elements

****
NOTE: For project designs requiring air-supply and distribution systems, consider using the optional choice of referencing Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM for the equipment in this paragraph.
****

[Heating coils and radiating fins shall be of suitable nonferrous alloy with [threaded] [brazed] fittings at each end for connecting to external piping. The heating elements shall be free to expand or contract without developing leaks and shall be properly pitched for drainage. The elements shall be tested under a hydrostatic pressure of 200 psig and a certified report of the test shall be submitted to the Contracting Officer.] [Heating coils shall be as specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM for types indicated.] Coils shall be suitable for use with water up to 250 degrees F.

2.16.4 Motors

Motors shall be provided with NEMA 250 general purpose enclosure. Motors and motor controls shall otherwise be as specified in Section 16415 ELECTRICAL WORK, INTERIOR.

2.16.5 Motor Switches

Motors shall be provided with manual selection switches with "Off," and "Automatic" positions and shall be equipped with thermal overload protection.

2.16.6 Controls

Controls shall be provided as specified in Section 15950 HEATING, VENTILATING, AND AIR CONDITIONING HVAC CONTROL SYSTEMS.

2.17 HEATING AND VENTILATING UNITS

Heating and ventilating units shall be as specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS.

2.18 WATER TREATMENT SYSTEM

****

NOTE: Typically, large amounts of makeup water will not be required for new closed loop heating systems. However, if a large amount of makeup water is anticipated, an automatic chemical feed system should be used in lieu of a shot feeder. The automatic system can be found in Section 15569 WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH.

****

The water treatment system shall be capable of [manually] [automatically] feeding chemicals into the heating system to prevent corrosion and scale within the heat exchanger and piping system. All water treatment equipment and chemicals shall be furnished and installed by a water treatment company regularly engaged in the installation of water treatment equipment and the provision of water treatment chemicals based upon water condition analyses. The water treatment company shall provide a water sample analysis taken from the building site, each month for one year.

2.18.1 Chemical Shot Feeder

A shot feeder shall be provided as indicated. Size and capacity of feeder shall be based upon local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping. All materials of construction shall be compatible with the chemicals being used.

2.18.2   Make Up Water Analysis

****
NOTE: A water analysis may be available from the user. If an analysis is not available, an analysis will be performed during the design, and appropriate data will be entered.
****

The make up water conditions reported per ASTM D 596 are as follows:

Date of Sample	[_____]
Temperature	[_____] degrees [F] [C]
Silica (SiO2)	[_____] ppm (mg/1)
Insoluble	[_____] ppm (mg/1)
Iron and Aluminum Oxides	[_____] ppm (mg/1)
Calcium (Ca)	[_____] ppm (mg/1)
Magnesium (Mg)	[_____] ppm (mg/1)
Sodium and Potassium (Na and K)	[_____] ppm (mg/1)
Carbonate (HCO3)	[_____] ppm (mg/1)
Sulfate (SO4)	[_____] ppm (mg/1)
Chloride (C1)	[_____] ppm (mg/1)
Nitrate (NO3)	[_____] ppm (mg/1)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] ppm (meq/1)
Noncarbonate Hardness	[_____] epm (meq/1)
Total Hardness	[_____] epm (meq/1)
Dissolved Solids	[_____] ppm (mg/1)
Fluorine	[_____] ppm (mg/1)
Conductivity	[_____] microsiemens/cm

2.18.3   Chemicals

The chemical company shall provide pretreatment chemicals that will remove and permit flushing of mill scale, oil, grease, and other foreign matter from the water heating system. The chemical company shall also provide all treatment chemicals required for the initial fill of the system and for a period of one year of operation. The chemical company shall determine the correct chemicals and concentrations required for the water treatment. The chemicals shall not be proprietary and shall meet required federal, state, and local environmental regulations for the treatment of heating water systems and discharge to the sanitary sewer. The chemicals shall remain stable throughout the operating temperature range of the system, and shall be compatible with pump seals and other elements of the system.

2.18.4   Glycol Solutions

****
NOTE: If freeze protection is not required, this paragraph should be deleted. When a glycol system is used, the size of the HVAC systems should be corrected due to changes in specific heat and

viscosity. ASHRAE's "HVAC Systems and Equipment Handbook" should be consulted for the appropriate calculation procedures. Ethylene glycol should be used for HVAC systems. However, if the heat transfer media has the possibility of mixing with a potable water system, propylene glycol should be used. The required concentration should be entered based upon the anticipated ambient temperature.

****

A [_____] percent concentration by volume of industrial grade [ethylene] [propylene] glycol shall be provided. The glycol shall be tested in accordance with ASTM D 1384 with less than 0.5 mils penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicate based inhibitors shall not be used. The solution shall be compatible with pump seals, other elements of the system, and all water treatment chemicals used within the system.

2.18.5 Test Kits

All required test kits and reagents for determining the proper water conditions shall be provided.

PART 3 EXECUTION

3.1 INSTALLATION

All work shall be installed as indicated and in accordance with the manufacturer's diagrams and recommendations.

3.2 COLOR CODE MARKING AND FIELD PAINTING

****

NOTE: Designer will coordinate color code marking with Section 09900. Color code marking for piping not listed in Table I of Section 09900, will be added to the table.

****

Color code marking, field painting of exposed pipe, and field painting of factory primed equipment shall be as specified in Section 09900 PAINTING, GENERAL.

3.3 WELDING

****

NOTE: If the need exists for more stringent pipe welding requirements, delete the sentences in the first set of brackets.

****

[Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.] Structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL. [Welding and nondestructive testing procedures for piping shall be as specified in Section 05093 WELDING, PRESSURE PIPING.]

3.4 PIPING

****

NOTE: Indicate on the drawings, the direction of piping pitch, details of branch take-offs from mains, and pipe size reductions.

****

Unless otherwise specified, pipe and fittings installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the job site and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cuttings or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall be so installed as to permit free expansion and contraction without causing damage to building structure, pipe, joints, or hangers. Changes in direction shall be made with factory made fittings, except that bending of pipe up to 4 inches will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center line radius of bends shall not be less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Vent pipes shall be installed through the roof as indicated and shall be flashed as specified. Horizontal mains shall pitch up or down in the direction of flow as indicated. The grade shall be not less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated. Unions and other components for copper pipe or tubing shall be brass or bronze. Connections between ferrous and copper piping shall be electrically isolated using dielectric unions.

3.4.1 Joints

Except as otherwise specified, joints used on steel pipe shall be threaded for fittings 1 inch and smaller; threaded or welded for 1-1/4 inches up through 2-1/2 inches; and flanged or welded for 3 inches and larger. Joints between sections of copper tubing or copper pipe shall be flared or sweated. Pipe and fittings 1-1/4 inches and larger installed in inaccessible conduits or trenches beneath concrete floor slabs shall be welded. Unless otherwise specified, connections to equipment shall be made with black malleable iron unions for pipe 2-1/2 inches or smaller in diameter, and with flanges for pipe 3 inches or larger in diameter.

3.4.2 Low Temperature Systems

Piping may have threaded, welded, flanged or flared, sweated, or grooved mechanical joints as applicable and as specified. Reducing fittings shall be used for changes in pipe sizes. In horizontal lines, reducing fittings shall be the eccentric type to maintain the top of the adjoining pipes at the same level.

3.4.3   Steam Systems

Piping may have threaded, welded, or flanged joints as applicable and as specified. Reducing fittings shall be used for changes in pipe sizes. In horizontal steam lines, reducing fittings shall be the eccentric type to maintain the bottom of the lines at the same level. Grooved mechanical joints shall not be used.

3.4.4   High And Medium Temperature Systems

Temperature systems shall have welded joints to the maximum extent practicable, except screwed joints and fittings may be used at connections to equipment and on piping 2-1/2 inches and smaller. Equipment connections 3 inches and larger shall be flanged. Piping connections 3 inches and larger may be welded or flanged. In horizontal lines, reducing fittings shall be the eccentric type to maintain the tops of adjoining pipes at the same level. Grooved mechanical joints shall not be used.

3.4.5   Threaded Joints

Threaded joints shall be made with tapered threads properly cut, and shall be made tight with PTFE tape complying with ASTM D 3308, or equivalent thread joint compound applied to the male threads only, and in no case to the fittings.

3.4.6   Welded Joints

Joints shall be fusion-welded unless otherwise required. Changes in direction of piping shall be made with welding fittings only. Branch connection may be made with either welding tees or branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains.

3.4.7   Flanged Joints or Unions

Flanged joints or unions shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and similar items. Flanged joints shall be faced true, provided with gaskets, and made square and tight. Full-faced gaskets shall be used with cast iron flanges.

3.4.8   Flared and Sweated Pipe and Tubing

Pipe and tubing shall be cut square and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned with an abrasive before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connection. Installation shall be made in accordance with the manufacturer's recommendations. Changes in direction of piping shall be made with flared or soldered fittings only. Solder and flux shall be lead free. Joints for soldered fittings shall be made with silver solder or 95:5 tin-antimony solder. Cored solder shall not be used. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided on all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing.

3.4.9   Mechanical Tee Joint

An extracted mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Joints shall be brazed in accordance with NAPHCC Plumbing Code. Soldered joints will not be permitted.

3.5 CONNECTIONS TO EQUIPMENT

Supply and return connections shall be provided by the Contractor unless otherwise indicated. Valves and traps shall be installed in accordance with the manufacturer's recommendations. Unless otherwise indicated, the size of the supply and return pipes to each piece of equipment shall be not smaller than the connections on the equipment. No bushed connections shall be permitted. Change in sizes shall be made with reducers or increasers only.

3.5.1 Low Temperature Water and Steam and Return Connections

Connections, unless otherwise indicated, shall be made with malleable iron unions for piping 2-1/2 inches or less in diameter and with flanges for pipe 3 inches or more in diameter.

3.5.2 High And Medium Temperature Water Connections

Connections shall be made with 2000 pound black malleable iron unions for pipe 3/4 inch or less in diameter and with flanges for pipe 1 inch and larger in diameter.

3.6 BRANCH CONNECTIONS

****

NOTE: Indicate on the drawings the direction of piping pitch, details of branch take-offs from mains, and pipe size reductions.

****

Branches shall pitch up or down as indicated, unless otherwise specified. Connection shall be made to insure unrestricted circulation, eliminate air pockets, and permit drainage of the system.

3.6.1 Low Temperature Water Branches

****

NOTE: If the system is not to be a one-pipe system, reference to the special flow fittings brackets will be deleted.

****

Branches taken from mains shall pitch with a grade of not less than 1 inch in 10 feet. [Special flow fittings shall be installed on the mains to bypass portions of water through each radiator. Special flow fittings shall be installed as recommended by the manufacturer.]

3.6.2 Steam Supply and Condensate Branches

Branches taken from mains shall pitch with a grade of not less than 1 inch in 10 feet, unless otherwise indicated.

3.6.3 High And Medium Temperature Water Branches

****

NOTE: The following is recommended in the sizing of branch line connections to a high or medium temperature water main:

The following table will be used in metric projects.

Diameter of main, mm	Diameter of branch line connection, mm
200	80 minimum
100, 125, 150	50 minimum
50, 65, 80	one pipe size larger than sized branch line, but not more than 50 mm in diameter

The following table will be used in projects prepared using English (IP) measurements.

Diameter of main, inches	Diameter of branch line connection, inches
8	3 minimum
4, 5, 6	2 minimum
2, 2-1/2, 3	one pipe size larger than sized branch line, but not more than 2 inches in diameter

****

Branches shall take off at 45 degrees in the direction of the fluid flow from the supply and return lines and should be branched from the top or upper half of the main line unless otherwise indicated. Abrupt reduction in pipe sizes shall be avoided.

3.7 RISERS

The location of risers is approximate. Exact locations of the risers shall be as approved. [Steam supply downfeed risers shall terminate in a dirt pocket and shall be dripped through a trap to the return line.]

3.8 SUPPORTS

****

NOTE: Steam and high or medium temperature water piping layout shall be analyzed for thermal stresses due to expansion. Spring hangers will be indicated on drawings and used to absorb vertical expansion of piping. Drawings shall detail anchors and pipe guide and indicate location. Submit expansion calculations, including guide and anchor reactions

for review.
****

3.8.1 General

****
NOTE: Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between panel points in excess of 22 kg (50 pounds) shall have the excess hanger loads suspended from panel points.
****

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. All piping subjected to vertical movement when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers. Where threaded rods are used for support, they shall not be formed or bent.

3.8.1.1 Seismic Requirements for Pipe Supports, Standard Bracing

****
NOTE: Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record and show on the drawings. Delete the bracketed phrase if seismic details are not included Sections 13080 and 15070, properly edited, must be included in the contract documents.
****

All piping and attached valves shall be supported and braced to resist seismic loads as specified under Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT [as shown on the drawings]. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for supports shall be as specified under Section 05120 STRUCTURAL STEEL.

3.8.1.2 Structural Attachments

Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material and installation shall be as specified under Section 05120 STRUCTURAL STEEL. [Pipe hanger loads suspended from steel joist panel points shall not exceed 50 pounds. Loads exceeding 50 pounds shall be suspended from panel points.]

3.8.1.3 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run.

3.8.2 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as specified as follows:

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle shall be used on all pipe 4 inches and larger.

h. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves.

i. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet,except that pipe shall be supported not more than 8 feet from end of risers, and at vent terminations.

j. Type 35 guides using steel, reinforced PTFE or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions and bearing loads encountered. Where steel slides do not require provision for restraint or lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate. Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, which ever is greater.

k. Except for Type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.

3.8.3 Piping in Trenches

****

NOTE: Detail the methods of supporting pipe in trenches.

****

Piping shall be supported as indicated.

3.9 PIPE SLEEVES

****

NOTE: Sleeves through waterproofing membrane are to be similar to that shown in Josam Manufacturing Co. Figure No. 26420 and couplings similar to that shown in Figure No. 26440. Typical details of pipe sleeves through walls, floors, and roofs are shown in TM 5-805-6, CAULKING AND SEALING. The applicable detail plates will be completed and included in the contract drawings. Sleeve thickness and square- and rectangular opening detail will be determined and indicated.

****

3.9.1 Pipe Passing Through Concrete or Masonry

Pipe passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Unless otherwise indicated, sleeves shall provide a minimum of 1/4 inch annular space between bare pipe or insulation surface and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe or cast iron pipe. Sleeves in nonbearing walls, floors, or ceilings may be steel pipe, cast iron pipe, or galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls and floors shall be sealed as indicated and specified in Section 07900 JOINT SEALING. Penetrations in fire walls and floors shall be sealed in accordance with Section 07840 FIRESTOPPING.

3.9.2 Pipes Passing Through Waterproofing Membranes

****

NOTE: Indicated on drawings details of pipes through flashing or waterproof membrane, and method of sealing.

****

Pipes passing through waterproofing membranes shall be installed through a

4 pound lead-flashing sleeve, a 16 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each having an integral skirt or flange. Flashing sleeve shall be suitably formed, and the skirt or flange shall extend 8 inches or more from the pipe and shall be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2 inches above the highest flood level of the roof or a minimum of 10 inches above the roof, whichever is greater, or 10 inches above the floor. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. At the Contractor's option, pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

3.9.3 Mechanical Seal Assembly

In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3.9.4 Counterflashing Alternate

As an alternate to caulking and sealing the annular space between the pipe and flashing sleeve or metal-jacket-covered insulation and flashing sleeve, counterflashing may be by standard roof coupling for threaded pipe up to 6 inches in diameter; lead-flashing sleeve for dry vents and turning the sleeve down into the pipe to form a waterproof joint; or tack-welded or banded-metal rain shield round the pipe and sealing as indicated.

3.9.5 Waterproofing Clamping Flange

Pipe passing through wall waterproofing membrane shall be sleeved as specified. In addition, a waterproofing clamping flange shall be installed as indicated.

3.9.6 Fire Seal

****

NOTE: Fire walls and fire partitions shall be designated on the drawings.

****

Where pipes pass through fire walls, fire partitions, fire rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07840 FIRESTOPPING.

3.9.7 Escutcheons

Escutcheons shall be provided at all finished surfaces where exposed piping, bare or covered, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe sleeves or to extensions of sleeves without any part of sleeves being visible. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheons shall be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrew.

3.10 ANCHORS

****

NOTE: Detail and indicate locations of pipe anchors.

****

Anchors shall be provided where necessary or indicated to localize expansion or prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed using turnbuckles where required. Supports, anchors, or stays shall not be attached in places where construction will be damaged by installation operations or by the weight or expansion of the pipeline.

3.11 PIPE EXPANSION

****

NOTE: Whenever possible, provisions for the expansion of piping will be made by offsets or changes in the direction of the run of pipe or by expansion loops. Expansion joints, when used, shall be installed in readily accessible locations. Location and details of offsets, expansion joints, and expansion loops will be shown.

****

The expansion of supply and return pipes shall be provided for by changes in the direction of the run of pipe, by expansion loops, or by expansion joints as indicated. Low temperature water and steam expansion joints may be one of the types specified. [High] [Medium] temperature water system expansion joints may be one of the joints specified, except slip-tube type.

3.11.1 Expansion Loops

Expansion loops shall provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. The loops shall be cold-sprung and installed where indicated. Pipe guides shall be provided as indicated.

3.11.2 Slip-Tube Joints

****

NOTE: Type I and III slip joint, packed expansion joints are adjustable gland type and require continuing maintenance to contain leakage and are now manufactured by only one company, making them

proprietary.
****

Slip-tube type expansion joints shall be used for steam and low temperature water systems only and shall be installed where indicated. The joints shall provide for either single or double slip of the connected pipes as indicated and for the traverse indicated. The joints shall be designed for a working temperature and pressure suitable for the application and in no case less than [_____] psig. The joints shall be in accordance with applicable requirements of EJMA Stds and ASME B31.1. End connections shall be flanged. Anchor bases or support bases shall be provided as indicated or required. Initial setting shall be made in accordance with the manufacturer's recommendations to allow for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer, but in any case shall be not more than 5 feet from expansion joint, except in lines 4 inches or smaller where guides shall be installed not more that 2 feet from the joint.

3.11.3 Bellows-Type Joint

Bellows-type joint design and installation shall comply with EJMA Stds standards. The joints shall be designed for the working temperature and pressure suitable for the application and shall be not less than 150 psig in any case.

3.11.4 Flexible Ball Joints

****
NOTE: Ball joints may often be used to advantage instead of loops and expansion joints. Where used, they must be indicated on drawings in detail. Guides for ball joints will be as recommended by the manufacturer. Design details will include dimension between ball center-points in offset leg, and the distance and direction of desired cold set from offset leg centerline. Each expansion unit will consist of two, three, or four joints, but in no case less than two joints, as required to handle the system expansion. The ball joint arrangement at each expansion location must provide for total movement. The ball joint only moves in an angular offset or rotation mode. The configuration of the ball joint link will permit a 2 or 3 ball joint offset to absorb axial and/or lateral movement, but not a single ball joint; therefore, if axial and/or lateral movement is expected, use a 2 or 3 ball joint offset.
****

Flexible ball joints may be threaded (to 2 inches only), flanged, or welded end as required. The ball-type joint shall be designed and constructed in accordance with the generally accepted engineering principle stated in ASME B31.1, and ASME BPV VIII Div 1, where applicable. Flanges shall conform to the diameter and drilling of ASME B16.5. Molded gaskets furnished shall be suitable for the service intended.

3.12 VALVES AND EQUIPMENT ACCESSORIES

****
NOTE: Indicate type and location of valves on the drawings.
****

3.12.1 Valves and Equipment

Valves shall be installed at the locations shown or specified, and where required for the proper functioning of the system as directed. Gate valves shall be used unless otherwise indicated, specified, or directed. Valves shall be installed with their stems horizontal to or above the main body of the valve. Valves used with ferrous piping shall have threaded or flanged ends and sweat-type connections for copper tubing.

3.12.2 Gravity Flow-Control Valve

****
NOTE: Paragraph will be deleted if the system is not to be used for heating domestic hot water or if the system is not an up-feed type with intermittent operation of the circulating pump. A flow-control valve is not required in such instances.
****

The valve to control the flow of water shall be installed in the supply main near the heat exchanger. The valve shall operate so that when the circulating pump starts, the increased pressure within the main will open the valve; when the pump stops, the valve will close. The valve shall be constructed with a cast iron body and shall be provided with a device whereby the valve can be opened manually to allow gravity circulation. The flow-control valve shall be designed for the intended purpose, and shall be installed as recommended by the manufacturer.

3.12.3 Thermometer Socket

A thermometer well shall be provided in each return line for each circuit in multicircuit systems.

3.12.4 Air Vents

****
NOTE: Indicate location of all air vents on the drawings and include details for high or medium temperature water vents.
****

Vents shall be installed where indicated, and on all high points and piping offsets where air can collect or pocket.

3.12.4.1 Water Air Vents

[High] [Medium] temperature water air vents shall be as indicated. Vent discharge lines shall be double-valved with globe valves and shall discharge into a funnel drain.

3.12.4.2 Steam Air Vents

Steam air vents shall be a quick-acting valve that continuously removes air. Valve shall be constructed of corrosion-resisting metal, shall be designed to withstand the maximum piping system pressure, and shall automatically close tight to prevent escape of steam and condensate. Vent shall be provided with a manual isolation valve. A vent shall be provided on the shell of each steam heat exchanger.

3.13 STEAM TRAPS

Float Traps shall be installed in the condensate line as indicated. Other steam traps shall be installed where indicated.

3.14 UNIT HEATERS

Unit heaters shall be installed as indicated and in accordance with the manufacturer's instructions.

3.15 INSULATION

Thickness of insulation materials for piping and equipment and application shall be in accordance with Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.16 TESTING AND CLEANING

3.16.1 Pressure Testing

The Contractor shall notify the Contracting Officer [_____] days before the tests are to be conducted. The tests shall be performed in the presence of the Contracting Officer. The Contractor shall furnish all instruments and personnel required for the tests. Electricity, steam, and water will be furnished by the Government. All test results shall be accepted before thermal insulation is installed. The entire low temperature heating system, including heat exchanger, radiators and fittings, shall be hydrostatically tested and proved tight under a pressure of 45 psig for a period of four hours.

3.16.2 Test of Backflow Prevention Assemblies

Backflow prevention assemblies shall be tested in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

3.16.3 Cleaning

After the hydrostatic and backflow prevention tests have been made and prior to the operating tests, the heat exchanger and piping shall be thoroughly cleaned by filling the system with a solution of 1 pound of caustic soda or 1 pound of trisodium phosphate per 50 gallons of water. Observe the proper safety precautions in the handling and use of these chemicals. The water shall be heated to approximately 150 degrees F, and the solution circulated in the system for a period of 48 hours, then drained and the system thoroughly flushed out with fresh water. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. The Contractor shall be responsible for maintaining the system in a clean condition until final acceptance. Bearings shall be lubricated with oil or grease as recommended by the manufacturer.

3.16.4 Water Treatment Testing

3.16.4.1 Water Quality Test

The heating water shall be analyzed [prior to the acceptance of the facility] [and] [a minimum of once a month for a period of one year] by the water treatment company. The analysis shall include the following information recorded in accordance with ASTM D 596.

Date of Sample	[_____]
Temperature	[_____] degrees F
Silica (SiO2)	[_____] ppm (mg/1)
Insoluble	[_____] ppm (mg/1)
Iron and Aluminum Oxides	[_____] ppm (mg/1)
Calcium (Ca)	[_____] ppm (mg/1)
Magnesium (Mg)	[_____] ppm (mg/1)
Sodium and Potassium (Na and K)	[_____] ppm (mg/1)
Carbonate (HCO3)	[_____] ppm (mg/1)
Sulfate (SO4)	[_____] ppm (mg/1)
Chloride (C1)	[_____] ppm (mg/1)
Nitrate (NO3)	[_____] ppm (mg/1)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] ppm (meq/1)
Noncarbonate Hardness	[_____] epm (meq/1
Total Hardness	[_____] epm (meq/1)
Dissolved Solids	[_____] ppm (mg/1)
Fluorine	[_____] ppm (mg/1)
Conductivity	[_____] microsiemens/cm

3.17 TESTING, ADJUSTING AND BALANCING

Except as specified herein, testing, adjusting, and balancing shall be in accordance with Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.18 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.19 FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the system.

3.20 FIELD TRAINING

A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided for a total period of [_____] hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the approved operation and maintenance manuals.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-15565 (March 1989)**
U.S. ARMY CORPS OF ENGINEERS **---------------------------**
Superseding
CEGS-15602.8 (October 1987)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 16 (June 1999)
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Latest change indicated by CHG tags

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03/89

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DEPARTMENT OF THE ARMY | **CEGS-15565 (March 1989)**
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Latest change indicated by CHG tags

****

SECTION 15565

HEATING SYSTEM; GAS-FIRED HEATERS
03/89

****

NOTE: This guide specification covers the requirements for gas-fired heaters, including unit heaters, wall furnaces, and infrared heaters. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.44	(1995) Gas-Fired Gravity and Fan Type Direct Vent Wall Furnaces
ANSI Z21.49	(1992; Z21.49a; Z21.49b) Gas-Fired Gravity and Fan Type Vented Wall Furnaces
ANSI Z21.66	(1996) Automatic Vent Damper Devices for Use with Gas-Fired Appliances
ANSI Z83.4	(1991; Z83.4a) Direct Gas-Fired Make-Up Air Heaters
ANSI Z83.6	(1990; Z83.6a; Z83.6b) Gas-Fired Infrared Heaters
ANSI Z83.8	(1996) Gas Unit Heaters
ANSI Z83.9	(1990; Z83.9a) Gas-Fired Duct Furnaces

INTERNATIONAL APPROVAL SERVICES (IAS)

IAS Directory	(1996) IAS Directory of AGA & CGA Certified Appliances and Accessories

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3; Rev 4) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1996; Errata) National Fuel Gas Code
NFPA 211	(1996; Errata 96-1) Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

UNDERWRITERS LABORATORIES (UL)

UL Gas&Oil Dir	(1996; Supple) Gas and Oil Equipment Directory

1.2 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for

information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Heating System; [_____].

Spare parts data for each different item of materials and equipment specified, after approval of the detail drawings, and not later than [_____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-04 Drawings

Heating System; [_____].

Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operation of the system. Detail drawings for space heating equipment, controls, associated equipment, and for piping and wiring. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-06 Instructions

Heating System; [_____].

[Six] [_____] complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and basic operating features. [Six] [_____] complete copies of maintenance instructions listing routine maintenance, possible breakdowns, repairs and troubleshooting guide. The instructions shall include simplified piping, wiring, and control diagrams for the system as installed.

SD-09 Reports

Testing, Adjusting, and Balancing; [_____].

Test reports shall be submitted in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

1.3 GENERAL REQUIREMENTS

1.3.1 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the equipment.

1.3.2 Equipment Guards

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto shall be completely enclosed or guarded. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be guarded or covered with insulation of type specified for service.

1.3.3 Verification of Dimensions

The Contractor shall become thoroughly familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Material and equipment shall be standard products of a manufacturer regularly engaged in manufacturing of the products. Equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

2.2 ELECTRICAL WORK

****

NOTE: Indicate motor type, class, and enclosure type on the drawings.

****

Electrical motor driven equipment shall be provided complete with motors, motor starters, and controls. Motors shall conform to NEMA MG 1. Electrical equipment and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics shall be as specified or indicated. Unless otherwise indicated motors of 1 Hp and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control specified. Each motor shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

2.3 HEATERS

****

NOTE: Heater mounting brackets and related hardware should be specified to be furnished by the equipment manufacturer with factory finish if project does not

warrant separate specification sections for miscellaneous metals and field painting.   Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Enginer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not provided. Sections 13080 and15070, properly edited, must be included in the contract documents Indicate all applicable vent pipe routing on drawing.

****

Heaters shall be equipped for and adjusted to burn [natural] [liquified petroleum] [dual fuel natural/liquified petroleum] gas. Each heater shall be provided with a gas pressure regulator that will satisfactorily limit the main gas burner supply pressure. Heaters shall have an intermittent or interrupted electrically ignited pilot or a direct electric ignition system. Safety controls shall conform to the ANSI standard specified for each heater. Mounting brackets and hardware shall be furnished by the heater manufacturer and shall be factory finished to match the supported equipment. Seismic details shall be in accordance with Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT [as indicated].

2.3.1   Direct Fired Make-Up Air Heaters

****

NOTE: Designer should choose inlet or discharge damper according to climate zone. Generally, locations which experience more than 2220 heating degree C days (4,000 heating degree F days) should use discharge dampers on units located outdoors, and inlet dampers on units located indoors. Applications in moderate climates can be specified at the designer's option.

****

Heaters shall be in accordance with ANSI Z83.4. Direct fired make-up air heaters use outside air directly ducted to the heater. The products of combustion generated by the heater are released into the outside air stream being heated. Heaters shall be equipped with [motorized [inlet] [and] [outlet]] [backdraft] dampers, [discharge air diffuser,] [duct collar,] [air filters,] [and] [bird screen]. Gas control valve shall be modulating type. Maximum air temperature rise during minimum burner fire shall be 7 degrees F. [Fan shall be two speed, with low speed approximately two-thirds of high speed]. Outdoor heaters shall be weatherized and shall have manufacturer's standard exterior finish for outdoor units. Motorized [inlet] [and] [outlet] dampers shall be closed when the unit is shut down. Dampers shall be interlocked to prevent burner operation when dampers are closed. Heaters shall be provided with a [space] [discharge air] thermostat, a low limit air stream thermostat, and an ambient air thermostat. The [space] [discharge air] thermostat shall control the modulating gas control valve. The low limit air stream thermostat shall shut down the entire unit if the discharge air temperature drops below the [space] [discharge] thermostat setting. The ambient air thermostat shall shut down the burner if the outside air exceeds the [discharge] [space] thermostat setting.

2.3.2 Unit Heaters

****
NOTE: Aluminum-clad steel heat exchangers will be satisfactory in most applications. Omit the aluminum-clad steel if there is a corrosive condition.
****

Heaters shall conform to requirements of ANSI Z83.8. Heat exchangers shall be [aluminum clad steel] [or] [stainless steel]. Air discharge section shall be equipped with adjustable [horizontal louvers] [and] [vertical louvers or fins]. Heater fan motors shall operate at a speed not in excess of 1,550 rpm for units with output capacities up to and including 60,000 Btuh's and not in excess of 1,200 rpm for units with capacities above 60,000 Btuh. Fan shafts shall be either directly connected to the driving motor, or indirectly connected by multiple V-belt drive. Fans in one unit shall be of the same size. Heaters shall be power-vented type, suitable for sidewall vent discharge and single-wall-thickness vent piping. Heaters shall have automatic ignition. Heaters shall employ metered combustion air with enclosed draft diverter (no open flue collar). Heaters shall have minimum steady state efficiencies of 80 percent at maximum rated capacity and 75 percent at minimum rated capacity that is provided and allowed by the controls. Heaters shall be provided with a space thermostat which controls both unit's fan and burner.

2.3.3 Wall Furnace

****
NOTE: ANSI Z21.49 defines the gravity type units which are designed to draw combustion air from within the space. ANSI Z21.44 defines the fan type units which designed to draw combustion air from outdoors. Indicate on the drawings the type of air discharge; top or front.
****

Wall furnace shall be the [gravity] [fan] type in accordance with [ANSI Z21.49] [ANSI Z21.44] and as indicated. Furnace shall have a minimum thermal efficiency of 77 percent. Furnace shall be provided with a space thermostat which controls both the unit's fan and burner.

2.3.4 Duct Furnace

****
NOTE: Aluminum-clad steel heat exchangers will be satisfactory in most applications. Omit the aluminum-clad steel if there is a corrosive condition.
****

Duct furnace shall be in accordance with ANSI Z83.9. Furnace shall be power-vented type, suitable for sidewall vent discharge and single wall thickness vent piping. Furnace shall have automatic ignition. Furnace shall employ metered combustion air with enclosed draft diverter (no open flue collar). Furnace heat exchangers shall be [aluminum clad steel] [or] [stainless steel]. Furnace shall have minimum steady state efficiency of 80 percent at maximum rated capacity and 75 percent at minimum rated capacity that is provided and allowed by the controls. Furnace shall be provided with a [space] [discharge air] thermostat which controls the unit's burner.

2.3.5 Infrared Heaters

****

NOTE: Unvented infrared heaters may be employed only in buildings with high ceilings such as shop buildings, industrial buildings, etc. Exhaust vents will not be located directly above infrared heaters. Where the units are used in metal buildings, the roof will be insulated and an adequate noncombustible vapor barrier will be provided. Unvented infrared heaters will not be used in hazardous areas. Select type of heater required and delete the inapplicable type of ventilation. Capacity of the exhaust system must be a minimum of 6.4 liters per second per 1000 Watt hour (4 cfm per 1,000 Btu per hour) input to properly dilute the carbon dioxide produced. Provision will be made to provide air to the space in an amount equal to the exhaust.

****

Heaters shall conform to the requirements of ANSI Z83.6 and shall be [vented] [or] [unvented] type [as indicated]. [Vented heaters shall be vented to the outside atmosphere.] Heater style shall be [surface combustion] [catalytic] or [tubular] type [as indicated]. Surface combustion or catalytic type heaters shall have not less than 2.5 square inches of burner surface per 1000 btuh, when the surface area is calculated by multiplying the length by the width of the exposed emitting surface only. Catalytic type heaters shall have a secondary radiating surface, rods, or screen. Reflector shape shall be [parabolic] [horizontal] [or] [standard] [as indicated]. Heaters shall be provided with space thermostats which control the unit's burner. Thermostats located in the direct radiation pattern shall be covered with a metal shield.

2.4 THERMOSTATS

****

NOTE: Single stage thermostats are used to control a unit at 100 percent capacity only. Two stage thermostats can be used to stage a unit's capacity to either 50 or 100 percent. Two stage thermostats are only applicable for unit heaters and duct furnaces.

****

Thermostats shall be the adjustable electric or electronic type. Control wiring required to complete the space temperature control system shall be included. Thermostats shall have a [3 degree F] differential and a set point range of [40 to 75 degrees F] [0 to 100 degrees F] [[40 to 75] [80 to 120] degrees F]. Thermostats shall be the [single] [two] stage type.

2.5 VENT PIPING

Vent piping shall conform to the requirements of NFPA 54. Plastic material polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.6 ELECTRIC AUTOMATIC VENT DAMPERS

Electric automatic vent dampers shall conform to the requirements of ANSI Z21.66 and shall be provided in the vents of heaters [except unvented infrared heaters] using indoor air for combustion air.

2.7 INSULATION

Insulation for piping and equipment and application shall be in accordance with Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.8 FACTORY FINISHES

Equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish.

PART 3 EXECUTION

3.1 INSTALLATION

Equipment shall be installed as indicated and in accordance with the recommendations of the equipment manufacturer and the listing agency, except as otherwise specified.

3.1.1 Heating Equipment

Heaters shall be installed with clearance to combustibles complying with minimum distances as determined by IAS
Directory, UL Gas&Oil Dir and as indicated on each heater approval and listing plate. Heaters shall be independently supported from the building structure as indicated and shall not rely on support from suspended ceiling systems.

3.1.2 Vents

Vent dampers, piping and structural penetrations shall be located as indicated. Vent damper installation shall conform to ANSI Z21.66. Vent pipes, where not connected to a masonry chimney conforming to NFPA 211, shall extend through the roof or an outside wall and shall terminate, in compliance with NFPA 54. Vents passing through waterproof membranes shall be provided with the necessary flashings to obtain waterproof installations.

3.1.3 Gas Piping

Gas piping shall be connected as indicated and shall comply with the applicable requirements at Section 15190 GAS PIPING SYSTEMS.

3.2 TESTING, ADJUSTING, AND BALANCING

Testing, adjusting, and balancing shall be as specified in Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.3 Training

****
NOTE: Insert the number of hours to train personnel for equipment operations. Consult equipment manufacturer for recommended time.
****

The Contractor shall conduct a training course for the maintenance and operating staff. The training period of [_____] hours normal working time shall start after the system is functionally complete but before the final acceptance tests. The training shall include all of the items contained in the approved operation and maintenance instructions as well as demonstrations of routine maintenance operations. The Contracting Officer shall be given at least two weeks advance notice of such training.

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-15566 (February 1989)**
U.S. ARMY CORPS OF ENGINEERS | **--------------------------**
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Latest change indicated by CHG tags

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02/89

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-- End of Section Table of Contents --

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DEPARTMENT OF THE ARMY — **CEGS-15566 (February 1989)**
U.S. ARMY CORPS OF ENGINEERS — **-------------------------**
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GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 13 (April 1999)
Includes Special Change (Tailoring Options) (June 1998)
Includes Text Adjustment Change (Section References) (June 1997)

Latest change indicated by CHG tags

****

SECTION 15566

WARM AIR HEATING SYSTEMS
02/89

****

NOTE: This guide specification covers the requirements for warm air heating systems used primarily in barracks, offices and other similar applications. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for gas fired unit, and oil fired unit. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

****

NOTE: Equipment listed in this section is not intended for family housing applications. Systems

are for use primarily in barracks, offices and other similar applications.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR DIFFUSION COUNCIL (ADC)

ADC 1062:GRD	(1984) Test Codes for Grilles, Registers, and Diffusers

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.47	(1993; Z21.47a) Gas-Fired Central Furnaces (Except Direct Vent Central Furnaces
ANSI Z21.66	(1996) Automatic Vent Damper Devices for Use with Gas-Fired Appliances

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 653/A 653M	(1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 117	(1997) Operating Salt Spray (FOG) Apparatus
ASTM D 520	(1995) Zinc Dust Pigment
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 1784	(1996) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM F 872	(1984; R 1990) Filter Units, Air Conditioning: Viscous-Impingement Type,

Cleanable

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.1	(1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter

INTERNATIONAL APPROVAL SERVICES (IAS)

IAS Appliances & Accessy Dir	(1996) IAS Directory of AGA & CGA Certified Appliances and Accessories

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3; Rev 4) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(1997; TIA 97-1) Installation of Oil Burning Equipment
NFPA NFPA 54/ANSI Z223.1	(1996; Errata) National Fuel Gas Code
NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(1996) Installation of Warm Air Heating and Air Conditioning Systems
NFPA 211	(1996; Errata 96-1) Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION (NAIMA)

NAIMA AH115	(1993) Fibrous Glass Duct Construction Standards

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Install Fire Damp HVAC	(1992) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
SMACNA HVAC Duct Const Stds	(1995; Addenda Nov 1997)) HVAC Duct Construction Standards - Metal and Flexible
SMACNA Leakage Test Mnl	(1985) HVAC Air Duct Leakage Test Manual

UNDERWRITERS LABORATORIES (UL)

UL 181	(1996; Rev Dec 1998) Factory-Made Air Ducts and Air Connectors
UL 214	(1997) Tests for Flame-Propagation of Fabrics and Films

UL 296	(1994; Rev Sep 1998) Oil Burners
UL 441	(1996; Rev Oct 1997) Gas Vents
UL 555	(1995) Fire Dampers
UL 641	(1995) Type L, Low-Temperature Venting Systems
UL 727	(1994; Rev Jan 1996) Oil-Fired Central Furnaces
UL 900	(1994; Rev thru Apr 1997) Test Performance of Air Filter Units
UL 1738	(1993; Rev thru Mar 1998) Venting Systems for Gas-Burning Appliances, Categories II, III and IV
UL Blg Mat Dir	(1998) Building Materials Directory
UL Elec Const Dir	(1998) Electrical Construction Equipment Directory
UL Fire Resist Dir	(1998) Fire Resistance Directory

1.2 GENERAL REQUIREMENTS

1.2.1 Standard Products

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the products. Equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

1.2.2 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the equipment.

1.2.3 Verification of Dimensions

The Contractor shall become familiar with all details of the work and working conditions, verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing any work.

1.2.4 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government

approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Heating Equipment; [_____].

Spare parts data for each different item of material and equipment specified, after approval of detail drawings and not later than [_____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 12 months operation, and a list of the parts recommended by the manufacturer to be replaced after [1] [and] [3] year(s) of service.

SD-04 Drawings

Heating Equipment; [_____].

Drawings shall consist of a complete list of equipment and material including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Drawings shall contain complete equipment wiring diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenance and equipment relationship to other parts of the work including clearances required for maintenance and operation.

SD-06 Instructions

Tests; [_____].

Proposed test procedures for ductwork leak and performance tests, at least 2 weeks prior to the start of related testing.

System Diagrams; GA.

Proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

SD-07 Schedules

Tests; [_____].

Proposed test schedules for ductwork leak test and performance tests, at least 2 weeks prior to the start of related testing.

Field Training; [_____].

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

SD-08 Statements

Similar Services; [_____].

Statement demonstrating successful completion of similar services on at least 5 projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section.

SD-09 Reports

Tests; [_____].

Test reports for the ductwork leak test and the performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

SD-19 Operation and Maintenance Manuals

Heating Equipment; [_____].

[Six] [_____] manuals listing step-by-step procedures required for system startup, operation, shutdown and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tool that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing [4] [_____] hour onsite response to a service call on an emergency basis.

1.3   DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.4   ELECTRICAL WORK

****

NOTE: Electrical characteristics, motor starter type, enclosure type, and maximum rpm should be shown on the drawings in the equipment schedules.

****

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 1 hp and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be in accordance with NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers shall be utilized for motors rated 10 hp or less. Adjustable frequency drives shall be used for larger motors.

PART 2 PRODUCTS

2.1 SELF-CONTAINED FURNACE

****

NOTE: Indicate on the drawings the unit's thermal output required, the nominal air temperature rise required, the calculated air flow rate, the unit's pressure requirements, the unit's air discharge (i.e. upflow, downflow, or horizontal), etc. These units generally range in size from 11.7 kW (40 MBtuh) up to 35.1 kW (120 MBtuh).

****

Furnace shall be a manufacturer's standard, self-contained, forced circulated air heating type furnace as indicated. Furnace and furnace components shall be completely factory-assembled and wired. Furnace casing shall be factory insulated and be compatible with the operating temperatures. Furnace shall be provided with removable service panels which allow access to all internal components requiring cleaning, servicing, or adjustment.

2.1.1 Gas-Fired Unit

****

NOTE: High efficiency type units will be specified unless the conventional type units are calculated to be more life cycle cost effective.

For conventional type furnace with a capacity less than 65.9 kW (225 MBtuh) require a minimum AFUE of 78 percent. For conventional type furnace with a capacity greater than 65.9 kW (225 MBtuh) require a minimum AFUE of 80 percent. For high efficiency type furnace require a minimum AFUE of 90 percent.

The first cost of a high efficiency, condensing type furnace is approximately 60 to 75 percent higher than the first cost of a conventional type furnace.

****

Gas-fired furnace shall be the [conventional] [high efficiency, condensing] type in accordance with ANSI Z21.47. Furnace design shall be certified by the AMERICAN GAS ASSOCIATION LABORATORIES (AGA). Furnace shall have a minimum certified Annual Fuel Utilization Efficiency (AFUE) of not less than [78] [80] [90] percent.

2.1.2 Oil-Fired Unit

****

NOTE: Furnace with a capacity less than 65.9 kW (225 MBtuh) require a minimum AFUE of 78 percent. Furnace with a capacity greater than 65.9 kW (225 MBtuh) require a minimum AFUE of 81 percent.

****

Oil-fired furnace shall be in accordance with UL 727 and have a minimum certified Annual Fuel Utilization Efficiency (AFUE) of [78] [81] percent.

2.2 FURNACE COMPONENTS

****

NOTE: Delete any of the following paragraphs which are inapplicable to a specific job (i.e. oil-fired components or gas-fired components). For example, oil-fired components are inapplicable to high efficiency furnaces and should be deleted when high efficiency furnaces are specified.

****

2.2.1 Oil-Burning Components

The equipment shall include the oil burner motor, ignition equipment safety devices, and accessories necessary for a full automatic system that conforms to UL 296. Oil-fired units equipped with programming controls shall be furnished with low oil-pressure switches in the fuel supply piping. Oil-fired units not equipped with programming controls shall be equipped with a delayed opening or shutoff valve. The valve shall automatically delay delivery of oil to the burner until such time as the combustion air fan and, when applicable, the induced draft fan are operated at rated speed.

2.2.2 Gas-Burning Components

Gas-burning equipment shall include the gas burners, ignition equipment, gas-control valve, gas piping, gas-pressure regulating valve, when applicable, and accessories necessary for a fully automatic system that is listed in IAS Appliances & Accessy Dir. Gas-fired units equipped with programming controls shall be furnished both with high and with low gas supply pressure switches in the fuel supply piping.

2.2.3 Ignition Systems

2.2.3.1 Gas-Fired Units

Ignition systems shall be of the direct spark, hot surface, or interrupted intermittent type with automatic electric ignition. The pilots shall be of the electrically-ignited proven type. Continuous pilots will not be permitted. Burner shall be designed in accordance with NFPA NFPA 54/ANSI Z223.1 and located so that parts are protected against overheating. Provisions shall be made in the burner housing for inspection of the pilot flame.

2.2.3.2 Oil-Fired Units

Ignition systems for oil-fired units shall be of the [direct-electrical spark type] [direct-electric spark type or interrupted type] in accordance with UL 296.

2.2.4 Supply Blowers

Blowers shall be centrifugal type. Blowers shall be statically and dynamically balanced. Lubrication points shall be located or extended, as required, to provide ready access for periodic lubrication. The direction of rotation shall be clearly and permanently marked on each blower housing. Blower speeds shall be single, or multispeed, as indicated, to provide the specified range of air temperature rises. Direct-drive blowers may have multiple speed motors to change blower speed. Belt-drive blowers shall be provided with an adjustable base and guard or enclosed in the unit casing. The belt drive shall be designed in accordance with the applicable Rubber Manufacturer's Association (RMA) power transmission belt specifications, with a service factor of at least 1.2. Shafts shall be supported by a minimum of two self-alining bearings. Blower speed shall be adjusted by the use of variable pitch drive sheaves.

2.2.5 Vents for Conventional furnaces

****

NOTE: Delete this paragraph if high efficiency furnaces are specified.

****

A 0.3125 inch diameter hole shall be provided in the vent stack not greater than 6 inches from the furnace flue outlet for sampling of the exit gases. A method shall be provided to seal the hole to prevent exhaust gases from entering the indoor space when samples are not being taken. Each exhaust stack shall be provided complete with bird screen and rain hood.

2.2.5.1 Gas-Fired Units

Vent piping shall be in accordance with UL 441, [Type B] [Type BW]. Vent shall conform to NFPA 211 and NFPA NFPA 54/ANSI Z223.1. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.2.5.2 Oil-Fired Units

Vent piping shall be in accordance with UL 641, Type L. Vent shall conform to NFPA 211. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.2.6 Vents for High Efficiency Furnaces

****

NOTE: Delete this paragraph if gas-fired high efficiency, condensing type furnaces are not used. Conventional vents are not needed for condensing furnaces due to the low exhaust air temperature. Precautions should be taken due to the acidic condition of the condensate. The location and size of the vents should be shown on the drawings. Consult NFPA NFPA 54/ANSI Z223.1, UL 1738, and available vendor data to design the vents. The

vents can be mounted on the roof or exterior wall with proper separation. The vents should be extended above the typical snow level. Vents should be located in such a manner as to prevent vandalism and to prevent discharge of condensate across walkways.

****

Direct venting shall be used for condensing type furnaces. Both the air intake and exhaust vents shall be sized and located as indicated on the drawings and as recommended by the boiler manufacturer. A separate combustion air intake vent and exhaust shall be provided for each furnace. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.2.6.1 Combustion Air Intake Vent

The combustion air intake piping shall be constructed of Schedule 40 PVC in accordance with ASTM D 1784. The vent shall be suitable for the temperature at the furnace combustion air intake connection point. Each intake shall be provided complete with bird screen.

2.2.6.2 Exhaust Vent

The exhaust vent piping shall be constructed of Schedule 40 CPVC or stainless steel in accordance with UL 1738 and the furnace manufacturer's recommendations. The exhaust vent shall be suitable for the maximum anticipated furnace exhaust temperature and shall withstand the corrosive effects of the condensate. A 0.3125 inch diameter hole shall be provided in the stack not greater than 6 inches from the furnace flue outlet for sampling of the exit gases. A method shall be provided to seal the hole to prevent exhaust gases from entering the indoor space when samples are not being taken. Each exhaust stack shall be provided complete with bird screen.

2.3 AIR CONDITIONING EQUIPMENT

Cooling coils, condensers and related equipment shall be as specified in Section 15653 AIR-CONDITIONING SYSTEM (UNITARY TYPE).

2.4 CONTROLS

Controls shall be provided as specified in Section 15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS.

2.5 AUTOMATIC VENT DAMPERS

****

NOTE: Delete this paragraph if high efficiency furnaces are specified.

****

Automatic vent dampers shall be provided in the vents of all gas burning equipment that uses indoor air for combustion. Vent dampers shall conform to ANSI Z21.66.

2.6 HUMIDIFIERS

****

NOTE: Delete inapplicable paragraphs. Verify steam availability if steam humidifiers are specified. Recirculating or reservoir type will not be used without automatic bleed where the supply water has a mineral content greater than 4 grams per liter (0.53 ounces per gallon). Capacity shall be computed as recommended by ARI 630 assuming average building construction and single glass windows are used in calculations.

****

2.6.1 Steam Spray Type

Steam spray humidifiers shall inject steam directly into the [surrounding air] [or] [air stream] as indicated. [Single grid humidifiers shall consist of a single copper distribution grid with pipe connection on one end and cap on the other end. Automatic steam control valves and condenser traps shall be field-installed.] [Enclosed grid shall be housed in a copper enclosure with a build-in condensate drain connection. Exposed grid shall be wick wrapped.] [Package type steam spray humidifiers shall be equipped to trap out and to re-evaporate condensate and to supply dry steam to a single distribution grid. Grid shall be steam jacketed and condensate drained. Unit shall trap excess condensate to return system. Package type steam spray humidifiers shall have modulating electric, electronic, or pneumatic steam control valve, as indicated.] Steam spray humidifiers shall be rated for humidifying capacity in pounds of steam per hour and at steam pressure as indicated.

2.6.2 Steam Diffuser Type

Diffuser units shall be of a design that will separate any condensate from steam supply and provide positive drain of condensate to waste and supply dry steam only to air stream. Humidifiers may be installed on single or multiple units. All materials shall be [noncorrosive materials] [Type 300 stainless steel.]

2.6.3 Operation

Humidifier shall be controlled by a manually adjustable humidistat [located in living spaces] [with sensing bulb in [return] [supply]]. Humidifier shall operate when the furnace operates. Humidistat shall be calibrated in percent relative humidity and shall be furnished by the humidifier manufacturer.

2.7 AIR FILTERS

****

NOTE: Normally, replaceable type filters shall be specified; however, permanent type filters may be included in the project specifications provided maintenance facilities are available for cleaning. References to inapplicable filter types will be deleted.

****

Air Filters shall be listed in accordance with requirements of UL 900.

2.7.1   Replaceable Media filters

Replaceable media filters shall be the [dry-media] [viscous adhesive] type, of the size required to suit the application. Filtering media shall be not less than 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Pad shall be enclosed in a holding frame of not less than 16 gauge galvanized steel, and equipped with quick-opening mechanism for changing filter media. The air flow capacity of the filter shall be based on net filter face velocity not exceeding [300] [_____] feet per minute, with initial resistance of [0.13] [_____] inches water gauge. Average efficiency shall be not less than [_____] percent when tested according to ASHRAE 52.1.

2.7.2   Sectional Cleanable Filters

Cleanable filters shall conform to ASTM F 872, and shall be [1] [2] inches thick. Viscous adhesive shall be provided in 5 gallon containers in sufficient quantity for 12 cleaning operations and not less than 1 quart for each filter section. One washing and charging tank shall be provided foe every 100 filter sections or fraction thereof. Each washing and charging unit shall consist of a tank and [single] [double] drain rack mounted on legs. Drain rack shall be provided with dividers and partitions to properly support the filters in the draining position. Initial pressure drop for the clean filters shall not exceed the applicable values listed in ASTM F 872.

2.8   FUEL-OIL SYSTEMS

Fuel oil systems shall conform to Section 13202 FUEL STORAGE SYSTEMS.

2.9   FUEL-GAS SUPPLY SYSTEM

Fuel-gas supply system shall be as specified in Section 15190 GAS PIPING SYSTEMS and Section 02556 GAS DISTRIBUTION SYSTEM.

2.10   DUCTWORK COMPONENTS

****

NOTE: The appropriate pressure classification from SMACNA HVAC Duct Const Stds, including points of changes in pressure classification, will be noted on the drawings.

****

2.10.1   Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA HVAC Duct Const Stds unless otherwise specified. Elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure Class 1/2, 1, and 2 inch w.g. ductwork shall meet the requirements of Seal Class C. Class 3 through 10 inch shall meet the requirements of Seal Class A. Sealants shall conform to fire hazard classification specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA HVAC Duct Const Stds. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar will not be acceptable.

2.10.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

2.10.1.2 Insulated Nonmetallic Flexible Duct Runouts

Flexible duct runouts shall be used only where indicated. Runouts length shall be as shown on the drawings, but shall not exceed 10 feet. Runouts shall be preinsulated, factory fabricated, and shall comply with NFPA 90A and UL 181. Either field or factory applied vapor barrier shall be provided. Where coil induction or high velocity units are supplied with vertical air inlets, a streamlined and vaned and mitered elbow transition piece shall be provided for connection to the flexible duct or hose. The last elbow to these units, other than the vertical air inlet type, shall be a die-stamped elbow and not a flexible connector. Insulated flexible connectors may be used as runouts. The insulated material and vapor barrier shall conform to the requirements of Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation material surface shall not be exposed to the air stream.

2.10.1.3 General Service Duct Connectors

A flexible duct connector approximately 6 inches in width shall be provided where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL Blg Mat Dir.

2.10.2 Fibrous Glass Ductwork

****

NOTE: Fibrous glass ducts will not be used in ductwork systems for medical facilities or in clean rooms with requirements equal to or exceeding Class 100. Refer to AFR 88-15 for use on Air Force projects.

****

Fibrous glass ductwork may be provided in lieu of sheet metal ductwork except that fibrous glass ductwork will not be allowed in fan and equipment rooms, where subject to traffic or weather damage, for outside air intakes, for risers of more than two stories, in kitchen or fume exhaust ducts, to convey solids or corrosive gases, in concrete, for burial below grade, as casings or housings, or in systems used for life support systems. Fibrous glass ductwork, including components, shall be fabricated in accordance with NAIMA AH115 where the velocity and the static pressure are within its scope. Where the velocity or static pressure exceeds these limits, the ductwork manufacturer shall certify that the ductwork is intended for the velocities and pressures to be encountered, and that the proposed installation meets all performance criteria specified herein for metal ductwork. Fibrous glass ductwork shall have the thermal equivalent of the insulation specified for metal ductwork in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Field or factory fabricated fibrous glass ductwork shall conform to UL 181, Class 1. Duct wall penetrations, traverse joints and longitudinal seams shall be sealed as instructed by the manufacturer by one of the methods prescribed by NAIMA AH115, where applicable, except that pressure sensitive tape shall not be used as a sealant. All items necessary for a complete installation shall be provided as specified for sheet metal duct systems.

2.10.3 Ductwork Accessories

2.10.3.1 Duct Access Doors

****

NOTE: Provide duct access doors at regular intervals to facilitate the cleaning of duct systems for applications requiring clean air supplies, such as hospitals, laboratories, electronics servicing and similar activities.

****

Access doors shall be provided in ductwork where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown, shall conform to SMACNA HVAC Duct Const Stds. Access doors shall be provided upstream and downstream of air flow measuring primaries and heating and cooling coils. Doors shall be minimum 15 by 18 inches, unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Doors 24 by 24 inches or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be the insulated type.

2.10.3.2 Fire Dampers

****

NOTE: The designer must indicate on the drawings the location of each fire damper and details of the damper installations. Fire dampers must be provided in accordance with NFPA 90A. Three-hour rated fire dampers must be specifically identified on plans.

****

Fire dampers shall be 1-1/2 hour fire rated unless otherwise indicated. Fire dampers shall conform to the requirements of NFPA 90A and UL 555. Fire dampers shall be automatic operating type and shall have a dynamic rating suitable for the maximum air velocity and pressure differential to which it will be subjected. Fire dampers shall be approved for the specified application, and shall be installed in accordance with their listing. Fire dampers shall be equipped with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, will not impair the operation of the damper. Sleeves or frames shall be equipped with perimeter mounting angles attached on both sides of the wall or floor opening. Ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies shall be constructed in conformance with UL Fire Resist Dir. Fire dampers shall be [curtain type with damper blades] [in the air stream] [out of the air stream] [or] [single blade type] [or] [multi-blade type]. Dampers shall not reduce the duct or the air transfer opening cross-sectional area. Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness. Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.10.3.3 Splitters and Manual Balancing Dampers

****

NOTE: Designer will indicate all volume dampers on the drawings. Diffuser and register volume dampers will not be used for balancing.

****

Splitters and manual balancing dampers shall be furnished with accessible operating mechanisms. Where operators occur in finished portion of the building, operators shall be chromium plated with all exposed edges rounded. Splitters shall be operated by quadrant operators or 3/16 inch rod brought through the side of the duct with locking setscrew and bushing. Two rods are required on splitters over 8 inches. Manual volume control dampers shall be operated by locking-type quadrant operators. Dampers and splitters shall be 2 gauges heavier than the duct in which installed. Unless otherwise indicated, multileaf dampers shall be opposed blade type with maximum blade width of 12 inches. Access doors or panels shall be provided for all concealed damper operators and locking setscrew. Unless otherwise indicated, the locking-type quadrant operators for dampers, when installed on ducts to be thermally insulated, shall be provided with stand-off mounting brackets, bases, or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer. Volume dampers shall be provided where indicated.

2.10.3.4 Air Deflectors and Branch Connections

Air deflectors shall be provided at duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections may be used in lieu of deflectors or extractors for branch connections. All air deflectors, except those installed in 90 degree elbows, shall be provided with an approved means of adjustment. Adjustment shall be made from easily accessible means inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, external adjustments shall be provided with stand-off mounting brackets integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Air deflectors shall be factory-fabricated units consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Air deflectors shall be factory or field assembled. Blade air deflectors, also called blade air extractors, shall be approved factory fabricated units consisting of equalizing grid and adjustable blade and lock. Adjustment shall be easily made from the face of the diffuser or by position adjustment and lock external to the duct. Stand-off brackets shall be provided on insulated ducts and are described herein . Fixed air deflectors, also called turning vanes, shall be provided in all 90 degree elbows.

2.10.4   Duct Sleeves, Framed Prepared Openings, Closure Collars

2.10.4.1   Duct Sleeves

Duct sleeves shall be provided for round ducts 15 inches in diameter or less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round ducts larger than 15 inches in diameter and square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 20 gauge galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53, Schedule 20 shall be used. Sleeve shall provide 1 inch clearance between the duct and the sleeve or 1 inch clearance between the insulation and the sleeve for insulated ducts.

2.10.4.2   Framed Prepared Opening

Openings shall have 1 inch clearance between the duct and the opening or 1 inch clearance between the insulation and the opening for insulated ducts.

2.10.4.3   Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 4 inches wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 15 inches in diameter or less shall be fabricated from 20 gauge galvanized steel. Collars for round duct larger than 15 inches and all square, and rectangular ducts shall be fabricated from 18 gauge galvanized steel. Collars shall be installed with fasteners on maximum 6 inch centers, except that not less than 4 fasteners shall be used.

2.10.5   Diffusers, Registers, and Grilles

****

NOTE: Refer to TM 5-805-4, Noise and Vibration Control, for noise criteria. Sound power levels required should be included in the appropriate schedule on the drawings.

If diffusers or registers or grilles are not required, reference to omitted items will be deleted. Specified performance characteristics peculiar to the omitted items will be deleted. If any one or two of the three types of units are omitted, the corresponding subparagraph will be deleted.
****

Units shall be factory-fabricated of steel, corrosion-resistant steel, or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified in accordance with ADC 1062:GRD. Inlets and outlets shall be sound rated and certified in accordance with ADC 1062:GRD. Sound power level shall be as indicated. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers, except linear slot diffusers. Linear slot diffusers shall be provided with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, they shall be protected by a grille or screen in accordance with NFPA 90A.

2.10.5.1 Diffusers

Diffuser types shall be as indicated. Ceiling mounted units shall be furnished with antismudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Diffusers shall be provided with air deflectors of the type indicated. Air handling troffers or combination light and ceiling diffusers shall conform to the requirements of UL Elec Const Dirfor the interchangeable use as cooled or heated air supply diffusers or return air units. Ceiling mounted units shall be installed with rims tight against ceiling. Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller. Return or exhaust units shall be similar to supply diffusers.

2.10.5.2 Registers and Grilles

Units shall be four-way directional-control type, except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 6 inches below the ceiling unless otherwise indicated. Return and exhaust registers shall be located 6 inches above the floor unless otherwise indicated. Four-way directional control may be achieved by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Grilles shall be as specified for registers, without volume control damper.

2.10.6 Louvers

****

NOTE: The designer will ensure that louver selection includes consideration of parameters such as pressure drop and water penetration.

****

Louvers for installation in exterior walls which are associated with the air supply and distribution system shall be as specified in Section 07600 SHEET METALWORK, GENERAL.

2.11 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123/A 123M or ASTM A 653/A 653M shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphated and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than 6, average creepage not greater than 10, no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through from the interior shall receive a final shop docket of zinc-rich protective paint in accordance with ASTM D 520, Type I.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: Reference NFPA 31 for oil-fired units. Reference NFPA NFPA 54/ANSI Z223.1 for gas-fired units.

****

The warm air heating installation shall conform to the requirements contained in NFPA 90A or NFPA 90B, as applicable. Combustion air supply and ventilation shall be in accordance with [NFPA 31] or [NFPA NFPA 54/ANSI Z223.1].

3.1.1 Furnaces

Foundations, settings, or suspensions for mounting equipment and accessories including supports, vibration isolators, stands, guides, anchors, clamps, and brackets shall be provided. Foundations and suspension for equipment shall conform to the recommendations of the manufacturer, unless otherwise indicated on drawings. Anchor bolts and sleeves shall be set accurately using properly constructed templates. Anchor bolts, when embedded in concrete, shall be provided with welded-on plates on the head end and guarded against damage until equipment is installed. Equipment bases shall be leveled, using jacks or steel wedges, and when resting on concrete shall be neatly grouted-in with a nonshrinking type of grout. Equipment shall be located as indicated and in such a manner that working space is available for all necessary servicing, such as shaft removal, replacing, or adjusting drives, motors, or shaft seals, air filters, access to automatic controls, humidifiers, and lubrication. Electrical isolation shall be provided between dissimilar metals for the purpose of minimizing galvanic corrosion. The interior of cabinets or casings shall be cleaned before completion of installation. The furnace shall be connected to the vent or chimney with the specified connectors, draft regulators, draft loads, and induced draft fans, as applicable, in accordance with NFPA 211.

3.1.2 Automatic Vent Dampers

Automatic vent dampers shall be installed in accordance with ANSI Z21.66.

3.1.3 Humidifiers

Humidifiers shall be installed in accordance with manufacturer's instructions and in an arrangement that will permit access and ease of maintenance. Piping, draining, manual shut-off valve, and solenoid valves when required for type of humidifier furnished shall be provided. Drain lines shall be provided for humidifiers and shall be piped to drains shown. Humidifiers installed in a bypass arrangement shall be provided with an integral damper that can be conveniently operated to regulate or shut off flow through the humidifier. To permit humidifier operation, a manual ON-OFF switch shall be provided near the humidifier. The ON-OFF switch may be integral with the humidifier. When humidifier is installed in glass fiber ductwork, ductwork shall be adequately reinforced to support the humidifier.

3.1.4 Access Panels

Access panels shall be provided for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and so located that the concealed items may be serviced and maintained or completely removed for replacement. Access panels shall be as specified in Section 05500 MISCELLANEOUS METAL.

3.1.5 Flexible Connectors

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NOTE: Flexible connectors will be provided where required to absorb expansion and contraction, isolate vibration, absorb noise, compensate offset motion, absorb continuous flexing, and relieve equipment from piping stresses. Where flexible connectors are needed to correct lateral, parallel, and angular misalignment, their use will be limited to maximum offset as recommended, in writing, by the manufacturer.

****

Pre-insulated flexible connectors and flexible duct shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

3.1.6 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct insulation shall be packed as specified in Section 07840 FIRESTOPPING for fire rated penetrations. For non-fire rated penetrations, the space shall be packed as specified in Section 07900 JOINT SEALING.

3.1.7   Metal Ductwork

Installation shall be in accordance with SMACNA HVAC Duct Const Stds unless otherwise indicated. Duct supports for sheet metal ductwork shall be in accordance with SMACNA HVAC Duct Const Stds, unless otherwise specified. Friction beam clamps indicated in SMACNA HVAC Duct Const Stds shall not be used. Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor form puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided. Where threaded rods are used, they not be formed or bent.

3.1.8   Fibrous glass Ductwork

Installation shall be in accordance with the manufacturer's written recommendations unless otherwise required in NAIMA AH115. Duct supports for fibrous glass ductwork shall conform to NAIMA AH115. In those cases not covered in NAIMA AH115, the written recommendation of the fibrous duct manufacturer shall be followed.

3.1.9   Air Filters

Air filters shall be installed [in heater casings] [in return air ducts at furnaces] [in return air grilles]. Fans or blowers shall not be operated until filters are installed. After completion of tests and before the building is accepted by the Government, the Contractor shall [furnish a new second set of replaceable filters, where utilized] [clean the permanent type filters].

3.1.10   Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection shall be provided. The distribution system (supply and return) shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.

3.1.11   Insulation

Thickness and application of insulation materials for ductwork and equipment shall be in accordance with Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.12   Duct Test Holes

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NOTE: The location of duct test holes will be shown on the drawings. Holes should be located so as to implement the requirements of Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

****

Holes with closures or threaded holes with plugs shall be provided in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Extensions, complete with cap or plug, shall be provided where the ducts are insulated.

3.1.13 Fuel-Oil System

Fuel oil systems shall be installed in accordance with Section 13202, FUEL STORAGE SYSTEMS.

3.2 FIELD PAINTING

Finish painting of items only primed at the factory or surfaces not specifically noted, otherwise are specified in Section 09900 PAINTING, GENERAL.

3.3 CLEANING

Ducts, plenums, and casings shall be thoroughly cleaned of all debris and blown free of all small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided prior to startup of all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. All equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.4 TESTS

Upon completion and prior to acceptance of the installation, the Contractor shall furnish all equipment, instruments, materials, labor, and supervision required for the tests as specified. Water, electricity, and fuel required for testing [shall] [will] be furnished by the [Contractor] [Government]. Defects disclosed by the tests shall be rectified. Tests shall be made under the direction and subject to the approval of the Contracting Officer. All indicating instruments shall be read at 1/2-hour intervals unless otherwise directed by the Contracting Officer.

3.4.1 Ductwork Leak Test

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NOTE: This paragraph may be omitted where all ductwork is constructed to static pressure Class 125, 250, or 500 Pa (1/2, 1 or 2 inch w.g.). Otherwise leakage rate will be derived for each system to be tested based on procedure outlined in SMACNA Leakage Test Mnl for Seal Class A. If round/oval metal ductwork only is specified, C sub L=3 will be used, otherwise C sub L=6 may be used. The value of P used will be equal to the highest duct static pressure class; i.e., 3, 4, 6, or 10, for the ductwork to be tested. Where major components such as fans, coils, filters, etc. will be included in the ductwork test, an appropriate

allowance will be included in the maximum allowable leakage rate.
****

Ductwork leak test shall be performed for the entire air distribution system, including fans, coils, [filters, etc.] [filters etc. designated as static pressure Class 3 inch w.g. through Class 10 in w.g.]. Test procedure, apparatus, and report shall conform to SMACNA Leakage Test Mnl. The maximum allowable leakage rate is [_____] cfm. Ductwork leak test shall be completed with satisfactory results prior to applying insulation to ductwork exterior.

3.4.2 Testing, Adjusting, and Balancing

Testing, adjusting, and balancing shall be as specified in SECTION 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Testing, adjusting, and balancing shall begin only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.4.3 Performance Tests

After testing, adjusting, and balancing has been completed as specified, each system shall be tested as a whole to see all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be conducted by an experienced engineer. Tests shall cover a period of not less than [_____] days for each system and shall demonstrate that the entire system is functioning according to the specifications. Coincidental chart recordings shall be made at points indicated on the drawings for the duration of the time period and shall record the temperature at space thermostats or space sensors, the humidity in a shaded and weather protected area.

3.5 FIELD TRAINING

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NOTE: The number of hours of instruction should be determined based on the number and complexity of the systems specified.
****

The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of [_____] hours of normal working time shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved operating and maintenance instructions.

-- End of Section --

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SECTION 15569

WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH
05/95

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NOTE: This guide specification covers the requirements for packaged hot water and steam boiler systems (oil, gas or combination oil/gas fired) of up to 6000 kW (20,000,000 Btuh) output capacity. The hot water boiler systems operate at water temperatures below 120 degrees C (250 degrees F) and water working pressures less than 1100 kPa (160 psi). The steam heating systems operate up to 100 kPa (15 psig). This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: Issue (date) of references included in wqproject specifications need not be more current

than provided by the latest change (Notice) to this guide specification.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 801	(1992) Industrial Process/Power Generation Fans: Specification Guidelines

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.13	(1991; Z21.13a; Z21.13b) Gas-Fired Low-Pressure Steam and Hot Water Boilers

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990; R 1995) Ferritic Malleable Iron Castings
ASTM A 47M	(1990; R 1996) Ferritic Malleable Iron Castings (Metric)
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 105/A 105M	(1997) Carbon Steel Forgings, for Piping Applications
ASTM A 106	(1997a) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 183	(1983; R 1998) Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	(1998) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 234/A 234M	(1997) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Services
ASTM A 366/A 366M	(1997) Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
ASTM A 515/A 515M	(1997) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A 516/A 516M	(1990; R 1996) Pressure Vessel Plates, Carbon Steel, for Moderate- and

	Lower-Temperature Service
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 653/A 653M	(1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 32	(1996) Solder Metal
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1997) Seamless Copper Tube
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 88M	(1996) Seamless Copper Water Tube (Metric)
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM B 828	(1992) Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM C 27	(1998) Fireclay and High-Alumina Refractory Brick
ASTM C 34	(1996) Structural Clay Load-Bearing Wall Tile
ASTM C 155	(1997) Standard Classification of Insulating Firebrick
ASTM C 401	(1991; R 1995) Alumina and Alumina Silicate Castable Refractories
ASTM D 596	(1991; R 1995) Reporting Results of Analysis of Water
ASTM D 1784	(1996) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2000	(1998c) Rubber Products in Automotive Applications
ASTM F 872	(1984; R 1990) Filter Units, Air Conditioning: Viscous-Impingement Type, Cleanable
ASTM F 876	(1997) Crosslinked Polyethylene (PEX) Tubing
ASTM F 1097	(1991; R 1996) Mortar, Refractory (High-Temperature, Air-Setting)

ASTM F 1139	(1988; R 1998) Standard Specification for Steam Traps and Drains

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Gray Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.15	(1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995; B16.22a) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(1997) Valves - Flanged, Threaded, and Welding End
ASME B16.39	(1986; R 1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B19.3	(1991; B19.3a; B19.3b) Safety Standard for Compressors for Process Industries
ASME B31.1	(1998) Power Piping
ASME B31.5	(1992; B31.5a) Refrigeration Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV IV	(1998) Boiler and Pressure Vessel Code; Section IV, Heating Boilers
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME CSD-1	(1998) Controls and Safety Devices for Automatically Fired Boilers
ASME PTC 10	(1997) Compressors and Exhausters

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(1997) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
AWS B2.2	(1991) Brazing Procedure and Performance Qualification

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1419	(Rev D) Filter Element, Air Conditioning (Viscous-Impingement and Dry Types, Replaceable)

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA Tube Handbook	(1995) Copper Tube Handbook

EXPASION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(1993; Addenda 1995; Errata 1996; 7th Ed. 1998) EJMA Standards

HYDRONICS INSTITUTE (HYI)

HYI-01	(1998) I=B=R Ratings for Boilers, Baseboard Radiation and Finned Tube (Commercial) Radiation
HYI-400	(1998) I=B=R, Product Floor Heating

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1990) Cast Iron Gate Valves, Flanged and Threaded Ends

MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-73	(1991; R 1996) Brazing Joints for Copper and Copper Alloy Pressure Fittings
MSS SP-78	(1998) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends
MSS SP-110	(1996) Ball Valves Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(1997 TIA 97-1) Installation of Oil Burning Equipment
NFPA 54	(1996; Errata) National Fuel Gas Code
NFPA 70	(1999) National Electrical Code
NFPA 211	(1996; Errata 96-1) Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances
NFPA 8501	(1997) Single Burner Boiler Operation

UNDERWRITERS LABORATORIES (UL)

UL 296	(1994; Rev Sep 1998) Oil Burners
UL 726	(1995) Oil-Fired Boiler Assemblies
UL 795	(1994; Rev Jan 1996) Commercial-Industrial Gas Heating Equipment
UL 1738	(1993; Rev thru Mar 1998) Venting Systems for Gas-Burning Appliances, Categories II, III and IV
UL Gas&Oil Dir	(1996; Supple) Gas and Oil Equipment Directory

1.2 GENERAL REQUIREMENTS

1.2.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.2.2 Asbestos Prohibition

Asbestos and asbestos-containing products shall not be used.

1.2.3 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the equipment. Each pressure vessel shall have an approved ASME stamp.

1.2.4 Equipment Guards

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified. Catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed in accordance with Section 05500 MISCELLANEOUS METAL.

1.2.5 Verification of Dimensions

The Contractor shall become familiar with details of the work, verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work or ordering any materials.

1.2.6 Welding

****

NOTE: Where pipeline, structural, or other welding is required on the same project, tests will be required accordingly. Testing may be by the coupon method as prescribed in the welding code or by special radiographic methods. If the need exists for more stringent pipe welding requirements, delete the sentences in the first set of brackets.

****

[Boilers and piping shall be welded and brazed in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with

Section 05090 WELDING, STRUCTURAL.] [Welding and nondestructive testing procedures for piping are specified in Section 05093 WELDING PRESSURE PIPING.]

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

Delete all references to radiant floor heating systems, if radiant floor heating is not needed for the building.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Manufacturer's Catalog Data; [_____].

Manufacturer's catalog data shall be included with the detail drawings for the following items:

Boilers
Fuel Burning Equipment
Combustion Control Equipment
Pumps
Fittings and Accessories
Fuel Oil Storage System
Water Treatment System

Radiant floor heating system including tubing, joints, and manifold for radiant floor heating systems.

The data shall show model, size, options, etc., that are intended for consideration. Data submitted shall be adequate to demonstrate compliance with contract requirements.

Spare Parts Data; [_____].

Spare parts data for each different item of material and equipment, after approval of the detail drawings and no later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service.

Water Treatment Plan; [_____].

[Six] [_____] complete copies of the proposed water treatment plan. The plan shall include a layout, control scheme, a list of the existing water conditions including the items listed in paragraph BOILER WATER TREATMENT, a list of all chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

Heating and Fuel Systems Test Procedures; [_____].

Proposed test procedures for the heating system tests and fuel system tests, at least 2 weeks prior to the start of related testing.

Welding Procedures; [_____].

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

Qualification; [_____].

A statement from the firms proposed to prepare submittals and perform installation and testing, demonstrating successful completion of similar services of at least five projects of similar size or scope, at least 2 weeks prior to the submittal of any other item required by this section.

Welding Qualification; [_____].

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

SD-04 Drawings

Heating System; [_____].

Detail drawings consisting of equipment layout including installation details and electrical connection diagrams; combustion and safety control diagrams; ductwork layout showing the location of supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of guides and anchors, the load imposed on each support or anchor (not required for radiant floor tubing), and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

SD-06 Instructions

Posted Instructions; FIO.

System layout diagrams that show the layout of equipment, piping, and ductwork and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system, framed under glass or laminated plastic, at least 2 weeks prior to the start of related testing. After approval, these items shall be posted where directed.

SD-07 Schedules

Tests; [_____].

Proposed test schedules for the heating system and fuel system tests, at least 2 weeks prior to the start of related testing.

SD-09 Reports

Heating System and Fuel System Tests; [_____].

Test reports for the heating system tests and the fuel system test, upon completion of testing complete with results.

Water Treatment Tests; [_____].

(1) The water quality test report shall identify the chemical composition of the boiler water. The report shall include a comparison of the condition of the boiler water with the manufacturer's recommended conditions. Any required corrective action shall be documented within the report.

(2) A test report shall identify the condition of the boiler at the completion of 1 year of service. The report shall include a comparison of the condition of the boiler with the manufacturer's recommended operating conditions.

SD-13 Certificates

Bolts; [_____].

Written certification by the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

Boiler Emissions; [_____].

Written certification by the boiler manufacturer that each boiler furnished complies with Federal, state, and local regulations for emissions. The certification shall also include a description of applicable emission regulations. If any boiler is exempt from the emission regulations, the certification shall indicate the reason for the exemption.

SD-19 Operation and Maintenance Manuals

Heating System; FIO.

[Six] [_____] complete manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, simplified wiring and control diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization shall be capable of providing [4] [_____] hour onsite response to a service call on an emergency basis.

Water Treatment System; FIO.

[Six] [_____] complete copies of operating and maintenance manuals for the step-by-step water treatment procedures, including procedures for testing the water quality.

1.4 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installing, adjusting, and testing of the equipment.

1.5 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be protected from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

PART 2 PRODUCTS

2.1 BOILERS

****

NOTE: A selection will be made between hot water and steam service. Also select between firetube, water tube, cast iron, and condensing type boilers. Condensing type boilers should only be considered for hot water service. Natural draft/atmospheric burners will not be used for any boiler exceeding 300 kW (1,000,000 Btuh) output. Inapplicable references shall be deleted.

****

Each boiler shall have the output capacity in British thermal units per hour (Btuh) as indicated when fired with the specified fuels. The boiler shall be furnished complete with the [oil] [gas] [combination oil/gas] burning equipment, boiler fittings and trim, automatic controls, [[forced] [induced] draft fan,] [natural draft/atmospheric burner,] electrical wiring, insulation, piping connections, and protective jacket. The boiler shall be completely assembled and tested at the manufacturer's plant. Boiler auxiliaries including fans, motors, drives, and similar equipment shall be provided with at least 10 percent excess capacity to allow for field variations in settings and to compensate for any unforeseen increases in pressure losses in appurtenant piping and ductwork. However, the boiler safety devices shall not be sized for a 10 percent excess capacity. The boiler and its accessories shall be designed and installed to permit ready accessibility for operation, maintenance, and service. Boilers shall be designed, constructed, and equipped in accordance with ASME BPV IV. Each boiler shall be of the [firetube] [watertube] [cast iron] [condensing] type and designed for [water] [steam] service as specified herein. The boiler capacity shall be based on the ratings shown in HYI-01 or as certified by the American Boiler Manufacturers Association, or American Gas Association.

2.1.1 Firetube Boiler

Boiler shall be self-contained, multipass, packaged type, complete with all accessories, mounted on a structural steel base. When the boilers is operating at maximum output, the heat input rates shall not be greater than 6,700 Btu/hr per square ft of fireside heating surface. The volume heat input rate shall not be less than 200,000 Btu/hr per cubic ft of furnace volume.

2.1.2 Watertube Boiler

Boiler shall be self-contained, packaged type, complete with all accessories, mounted on a structural steel base. The heat input rate for finned tube designs shall not be greater than 12,000 Btu/hr per square ft based on internal heater area. The heat input rate for other boilers shall not be greater than 6,700 Btu/hr per square ft of fireside heating surface.

2.1.3 Cast Iron Boiler

Boiler shall be of the rectangular, sectional type, self-contained, packaged type, complete with accessories, mounted on a structural steel base. Cast iron sections shall be free of leaks under all operating conditions. Access shall be provided to permit cleaning of internal tube surfaces.

2.1.4 Condensing Boiler

****

NOTE: Condensing boilers should only be selected when justified by a life cycle cost analysis. Due to the sulfur content of fuel oil, condensing boilers should only be considered if natural gas is used.

The lower the return temperature of water entering the boiler the higher the resulting boiler efficiency. (See ASHRAE HVAC Equipment and Applications Handbook). The return water temperature should be at or below the dew point of the flue gas to result in the formation of condensate. This condition may not occur within a steam heating system. Therefore, condensing boilers should only be used for hot water service. In addition, the water distribution system and heating coils be designed for higher temperature differentials.

Condensing boilers may be in the form of fire tube boilers with pulse combustion, copper fire tube boilers, or multiple heat exchanger boilers. The military specifications listed in the preceding paragraphs concerning fire tube and water tube boilers do not apply to condensing boilers.

****

Each boiler shall be a self-contained packaged type, complete with accessories, mounted on a structural steel base or a steel base which is integral to the boiler shell. Each boiler shall conform to the commercial design used by the manufacturer and shall permit free thermal expansion without placing undue stress on any part of the boiler. Each boiler which experiences the formation of condensate within the flue gas shall be specifically designed for condensing application. Each boiler shall withstand the corrosive effects of condensate for each part which may be in contact with the condensate at all possible operating conditions. Each boiler shall be provided with a separate air intake, exhaust, and condensate drain. Each boiler shall be designed to withstand the water temperature differentials anticipated at the required operating conditions without experiencing any damage due to thermal shock.

2.1.5 Modular Configuration

****

NOTE: A modular configuration is a series of small cast iron type and/or condensing type boilers. The smaller boilers are manifolded together to provide heating for larger loads. This arrangement may be economical when heating load variances are expected. Delete this paragraph if a modular configuration is not desired.

****

Modular boilers shall be of the [cast iron] [and] [condensing] type. Modular boilers shall have the capability of independent operation. Upon failure of any module, the remaining modules shall be capable of operating at their designed capacity. The size of the individual modules shall be as indicated.

2.1.6 Hot Water Heating Boilers

****

NOTE: Hot water heating boilers will operate at pressures not over 1100 kPa (160 psi) and at temperatures not above 120 degrees C (250 degrees F) at or near the boiler outlet. If a pressure above 200 kPa (30 psi) is selected, the boiler may be required to be manned 24 hours a day. Consult AR 420-49 for boiler attendance requirements. Fill in blank spaces to define operating conditions, under the listed subparagraphs which are not applicable to the design. Indicate the elevation of the project site and outdoor ambient air temperature range expected at the project site. Site conditions affect fan selection, boiler design, and stack design. Select appropriate boiler types. Allow adequate space around each boiler to permit accessibility for operation, maintenance, and service (including space for tube removal). A minimum clearance of 1200 mm (4 feet) around the boiler will be required unless modular boilers are specified. Some modular boilers installations require little or no room between the individual boilers.

****

The hot water heating boiler shall be capable of operating at the specified maximum continuous capacity without damage or deterioration to the boiler, its setting, firing equipment, or auxiliaries. The rated capacity shall be the capacity at which the boiler will operate continuously while maintaining at least the specified minimum efficiency. The boiler design conditions shall be as follows:

a. Boiler design pressure [30] [_____] psig.

b. Operating pressure at boiler outlet [_____] psig.

c. Hot water temperature [160] [180] [_____] degrees F.

d. Temperature differential between boiler discharge and system return [_____] degrees F.

e. Water pressure drop [10] [_____] psig.

f. Outdoor ambient air temperature [_____] degrees F (max), [_____] degrees F (min).

g. Site elevation [_____] feet.

h. Maximum continuous capacity [_____] Btuh.

i. Rated capacity [_____] Btuh.

j. Maximum exhaust stack temperature [_____] degrees F.

k. [Boilers with a capacity less than 300,000 Btuh shall have an Annual Fuel Utilization Efficiency of at least 80 percent.] [Gas fired boilers with a capacity of greater than or equal to 300,000 Btuh shall have a combustion efficiency of at least 80 percent when fired at the maximum and minimum ratings allowed by the controls.] [Oil fired boilers with a capacity of greater than or equal to 300,000 Btuh shall have a combustion efficiency of at least 83 percent when fired at the maximum and minimum ratings allowed by the controls.] [Condensing boilers shall have an Annual Fuel Utilization Efficiency of at least 90 percent].

2.1.7 Steam Heating Boilers

****

NOTE: Steam boilers will operate at pressures below 100 kPa (15 psi). In case of installation of a small boiler where the omission of the water column is standard in some manufacturers, the water column requirement and other inapplicable words will be deleted. However, if the water column requirement is deleted from the specification, a visible water column shall be included in the external piping arrangement to the boiler. The boiler feed water piping shall contain a loop or trap. The bottom portion of the trap shall be below the anticipated water level within the boiler. All piping arrangements will be shown on the drawings. Delete those subparagraphs which are not applicable to the design. Indicate the elevation of the project site and the outdoor ambient air temperature range expected at the project site. Site conditions affect fan selection, boiler design, and stack

design. The feed water temperature shall be selected to avoid thermal shock. Typical ranges are between 10 degrees C (20 degrees F) and 20 degrees C (40 degrees F) below the boiler outlet temperature. The boiler manufacturer should be consulted for proper selection. Select appropriate boiler types. Allow adequate space around each boiler to permit accessibility for operation, maintenance, and service (including space for tube removal). A minimum of 1200 mm (4 feet) around the boiler will be required.

****

The boiler shall be provided with a water column with gauge glass and fittings including water column and gauge glass drain valves of the straight through type. The steam heating boiler shall be capable of operating at the specified maximum continuous capacity without damage or deterioration to the boiler, its setting, firing equipment, or auxiliaries. The rated capacity shall be the capacity at which the boiler will operate continuously while maintaining at least the specified minimum efficiency. Design conditions shall be as follows:

a. Boiler design pressure 30 psig.

b. Operating pressure at boiler outlet [_____] psig.

c. Steam temperature 250 degrees F.

d. Feedwater temperature [_____] degrees F.

e. Outdoor ambient air temperature [_____] degrees F (max), [_____] degrees F (min).

f. Site elevation [_____] feet.

g. Maximum continuous capacity [_____] pounds of steam per hour.

h. Rated capacity [_____] pounds of steam per hour.

i. Maximum exhaust stack temperature [_____] degrees F.

j. [Boilers with a capacity less than 300,000 Btuh shall have an Annual Fuel Utilization Efficiency of at least 75 percent.] [Gas fired boilers with a capacity of greater than or equal to 300,000 Btuh shall have a combustion efficiency of at least 80 percent when fired at the maximum and minimum ratings allowed by the controls.] [Oil fired boilers with a capacity of greater than or equal to 300,000 Btuh shall have a combustion efficiency of at least 83 percent when fired at the maximum and minimum ratings allowed by the controls.]

2.2 FUEL BURNING EQUIPMENT

****

NOTE: Include all the required data for proper design of the boiler. Delete all references to fuels which will not be used. When firing fuel oil, include nitrogen and sulfur content of fuel for

emission requirements.

Review the Clean Air Act Amendment of 1990 (CAAA) and other applicable Federal, state, and local regulations early in the design phase to determine the appropriate emission limitations and monitoring requirements.

The CAAA does not require the application of low NOx burner (LNB) technology for boilers within the size range of this specification. The CAAA limits SO2 emissions for fuel oil fired boilers over 10.55 gJ (10,000,000 Btu) to 21.5 kg/nJ (0.5 lb per million Btu) input or to firing oil with less than 0.5 weight percent sulfur. However, state implementation plans may place limits on NOx and particulates and more stringent requirements on SO2.

Many options are available to reduce NOx emissions. The nitrogen and sulfur content of fuel oil should be specified in the fuel purchase contract. Restrictions on the nitrogen content will limit fuel flexibility. A careful analysis of proposed NOx reduction technologies must be performed to account for any required changes to auxiliary equipment and to identify future increase in O&M costs. Important questions that should be answered and be a part of the evaluation include the performance of NOx reduction over the entire load range, performance during backup fuel firing, and performance over the lifetime of the unit.

The majority of NOx control techniques can be defined as combustion modifications. The goals of combustion modification include redistribution of air and fuel to slow mixing, reduction of O2 in NOx formation zones, and reduction of the amount of fuel burned at peak flame temperatures.

Combustion modifications primarily deal with the control of fuel and air. Vertical staging includes overfire air (OFA) ports above the main combustion zone. Horizontal staging use registers or other devices to introduce air at different points along the flame. Fuel staging establishes a fuel rich zone above an air lean main combustion zone. Burner Out of Service (BOOS) techniques direct fuel to lower burner levels, while operating upper burners with air only. Flue Gas Recirculation (FGR) reduces O2 available to react with nitrogen and cools the flame. In addition to low NOx burners (LNB), OFA and BOOS other combustion modification techniques include fuel biasing, low excess air (LEA) and fuel reburning. Oil fired burners have successfully used

advanced oil atomizers to reduce NOx without increasing opacity. Oil/water emulsion is a technique to reduce NOx on smaller industrial boilers.

Consideration will be given to the unique installation and space requirements of various NOx reduction systems. LNB may or may not require pressure port modifications. FGR involves routing large ductwork. OFA is very effective and involves modification to pressure parts. Fuel staging requires pressure port modifications for reburn fuel injection and/or OFA ports.

****

Boiler shall be designed to burn [gas] [oil] [combination gas and oil]. Each boiler shall comply with Federal, state, and local emission regulations. As a minimum, the following emission requirements shall be met:

NOx - [[_____] lb per million Btu input] [parts per million (ppm) corrected to 3% 02].

SO2 - [[_____] lb per million Btu input] [parts per million (ppm) corrected to 3% 02].

Particulate - [[_____] lb per million Btu input] [parts per million (ppm) corrected to 3% 02].

2.2.1 Burners

****

NOTE: If No. 4, 5, or 6 oil will be one of the fuels, requirements for burners and accessories for these heavy oils will be inserted in the project specification.

****

2.2.1.1 Gas and Combination Gas-Oil Fired Burners and Controls

Burners shall be UL approved [mechanical draft burners with all air necessary for combustion supplied by a blower where the operation is coordinated with the burner] [natural draft/atmospheric burners]. Burner shall be provided complete with fuel supply system in conformance with the following safety codes or standards:

a. Gas-fired units with inputs greater than 400,000 Btuh per combustion chamber shall conform to UL 795. [Gas fired units less than 12,500,000 Btuh input shall conform to ANSI Z21.13.] [Single burner gas-fired units greater than or equal to 12,500,000 Btuh input shall conform to NFPA 8501. Multiple burner gas-fired units greater than or equal to 12,500,000 Btuh input shall conform to NFPA 8501.]

b. Combination gas and oil-fired units shall conform to UL 296. [Combination gas and oil-fired units less than 12,500,000 Btuh input shall conform to ASME CSD-1.] [Single burner combination gas and oil-fired units equal to or greater than 12,500,000 Btuh input shall conform to NFPA 8501. Multiple burner combination gas and oil-fired units greater than or equal to 12,500,000 Btuh input shall conform to NFPA 8501.]

2.2.1.2 Oil-Fired Burners and Controls

Oil-fired burners and controls for oil-fired units firing No. [_____] oil shall be atomizing, forced-draft type in conformance with UL 726. [Oil-fired units less than 12,500,000 Btuh input shall conform to ASME CSD-1.] [Single burner combination gas and oil-fired units greater than or equal to 12,500,000 Btuh input shall conform to NFPA 8501.]

2.2.1.3 Steam or Air Atomizer

****

NOTE: Delete this paragraph if steam or air atomization is not used.

****

[Steam] [or] [air] atomizer shall be of the inside mix type utilizing [steam] [or] [air] mixing with the oil inside the nozzle. No moving parts shall be required within the atomizer assembly. Unit shall be capable of completely atomizing the oil through a minimum capacity range of 4 to 1 without changing nozzles or sprayer plates and when supplied with [steam] [or] [air] at a maximum pressure of [15] [_____] psig. Capacity of unit shall be adjustable. Unit shall be furnished with a blowout valve so that [steam] [or] [air] may be blown through the oil passages to clear them of any accumulation. A diffuser designed to stabilize the flame shall be mounted near the furnace end of the atomizer in such a position that oil will not strike it.

2.2.1.4 Mechanical pressure atomizer

****

NOTE: If mechanical pressure atomization is not used delete this paragraph.

****

Mechanical pressure atomizer shall operate solely by the use of oil pressure and shall have no moving parts within the atomizer. Unit shall be capable of completely atomizing the oil through a minimum capacity range of 4 to 1 without changing nozzles or sprayer plates and when furnished with oil at a constant pressure of [_____]. A constant volume of oil shall be supplied to the atomizer. Variable capacity shall be obtained by adjusting control valve. A diffuser provided to stabilize the flame shall be mounted near the furnace end of the atomizer, but in such a position that oil will not strike it.

2.2.2 Draft Fans

****

NOTE: If natural draft/atmospheric burners are utilized, all draft fan paragraphs will be deleted. Select between forced draft and induced draft fan or a combination of both. In most applications, a forced draft fan will be adequate. Fan bearings on induced draft fans must have adequate means to

prevent overheating and provision for lubrication. Choice of type of cooling will depend on availability of water for the particular site. Water-cooled bearings are generally used for induced draft fans but air-cooled, sealed-type bearings are available; however, their use must be approved by the fan manufacturer for the application if specified. Forced draft fans are typically air cooled.

****

Fans conforming to AMCA 801 [forced-draft] [and] [induced-draft] shall be furnished as an integral part of boiler design. Fans shall be centrifugal with [backward-curved blades] [radial-tip blades] or axial flow type. Each fan shall be sized for output volume and static pressure rating sufficient for pressure losses, excess air requirements at the burner, leakages, temperature, and elevation corrections for worst ambient conditions, all at full combustion to meet net-rated output at normal firing conditions, plus an overall excess air volume of 10 percent against a 20 percent static overpressure. Noise levels for fans shall not exceed 85 decibels in any octave band at a 3 foot station. [Forced draft fan bearings shall be air cooled.] [Induced-draft fans shall be designed for handling hot flue gas at the maximum outlet temperature in the boiler. Induced draft fan housings shall be provided with drain holes to accommodate the drainage of condensation. Induced draft fan bearings shall be [air-cooled] [water-cooled]. Induced draft fan scroll sheets and rotor blades shall have protective liners.]

2.2.2.1 Draft Fan Control

[Forced-draft centrifugal fans shall have inlet vane controls or shall have variable speed control where indicated. Inlet vanes shall be suitable for use with combustion control equipment.] [Induced-draft centrifugal fans shall have outlet dampers and shall have variable speed control.] [Induced-draft fans shall have inlet vane controls.] Axial propeller fans shall have variable propeller pitch control.

2.2.2.2 Draft Fan Drives

****

NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

****

Fans shall be driven by electric motors. Electric motor shall be [drip proof] [totally enclosed nonventilated] [totally enclosed fan cooled] [totally enclosed fan-cooled, suitable for installation in a Class II, Division 1, Group F, hazardous location conforming to NFPA 70]. [Motor starter shall be [magnetic across-the-line] [reduced voltage start] type with [general purpose] [weather-resistant] [watertight] [dust-tight] [explosion-proof] enclosure and shall be furnished with four auxiliary interlock contacts.]

2.2.3 Draft Damper

****

NOTE: Select between manual and automatic dampers.

Normally, manual dampers are adequate for single boilers less than 600 kW (2,000,000 Btuh) capacity. Select automatic dampers for modular boilers.
****

Boilers shall be provided with [manual] [automatic] dampers, draft hoods, or barometric dampers as recommended by the boiler manufacturer to maintain proper draft in the boiler. Draft damper shall be provided in a convenient and accessible location in the flue gas outlet from the boiler. Automatic damper shall be arranged for automatic operation by means of a [damper regulator] [furnace draft regulator] [damper motor].

2.2.4   Ductwork

****
NOTE: In colder climates, tempering of combustion air may be required. Add an appropriate paragraph for tempering combustion air, if required. Delete this paragraph, if a plenum chamber is not needed.
****

Air ducts connecting the forced-draft fan units with the plenum chamber shall be designed to convey air with a minimum of pressure loss due to friction. Ductwork shall be galvanized sheet metal conforming to ASTM A 653/A 653M. Ducts shall be straight and smooth on the inside with laps made in direction of air flow. Ducts shall have cross-break with enough center height to assure rigidity in the duct section, shall be angle iron braced, and shall be completely free of vibration. Access and inspection doors shall be provided as indicated and required, with a minimum of one in each section between dampers or items of equipment. Ducts shall be constructed with long radius elbows having a centerline radius 1-1/2 times the duct width, or where the space does not permit the use of long radius elbows, short radius or square elbows with factory-fabricated turning vanes may be used. Duct joints shall be substantially airtight and shall have adequate strength for the service, with 1-1/2 x 1-1/2 x 1/8 inch angles used where required for strength or rigidity. Duct wall thickness shall be 16 gauge (0.0598 inch) for ducts 60 inches or less and 12 gauge (0.1046 inch) for ducts larger than 60 inches in maximum dimension. Additional ductwork shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

2.3   COMBUSTION CONTROL EQUIPMENT

****
NOTE: If steam boilers are not utilized, all references to steam pressure controllers shall be deleted. If hot water boilers are not utilized, all references to water temperature controllers shall be deleted.

Controls for facilities with operating Energy Monitoring and Control Systems (EMCS) will be specified to be compatible with existing EMCS controls. Delete reference to multiple boilers if a single boilers is used.
****

Combustion control equipment shall be provided as a system by a single manufacturer. Field installed automatic combustion control system shall be installed in accordance with the manufacturer's recommendations and under the direct supervision of a representative of the control manufacturer. [The boiler water temperature shall be controlled by a water temperature controller.] [The boiler pressure shall be controlled by a steam pressure controller.] The equipment shall operate either electrically or pneumatically. On multiple boiler installations, each boiler unit shall have a completely independent system of controls responding to the load and to a plant master controller. If recording instruments are provided, a 1 year supply of ink and 400 blank charts for each recorder shall be furnished.

2.3.1 Pneumatic Controls

If pneumatic operation is provided, a regenerant desiccant air dryer unit shall be provided. Boiler shall shut down on loss of control air pressure. Pneumatic control systems shall conform to ASME B19.3. Air filter regulator sets shall be installed at each control valve and transmitter in the system. The master air filter regulator set on the control panel shall be the dual type where one side can be cleaned and repaired while the other is operating. Exterior control air piping and devices shall be protected form freezing.

2.3.1.1 Air Compressor Unit

The air compressor unit shall be electric-motor driven, polytetrafluoroethylene or carbon ring type automatic air compressor. The compressor unit shall be sized to run not more than 60 percent of the time when all controls are in service. The air compressor unit shall be complete with necessary accessories including automatic pressure control equipment, relief valves, check valves, air filters, moisture traps, and a receiver with ample capacity for emergency operation of the controls for 15 minutes after compressor shutdown. Compressor speed shall not exceed 900 rpm. Motor speed shall not exceed 1750 rpm. The compressor air intake shall be provided with a low drop type air suction filter/silencer suitable for outdoor installation.

2.3.1.2 Air Receiver

****

NOTE: The condensate drain line will be located in such a manner as to prevent freezing.

****

The air receiver shall be constructed in accordance with ASME BPV VIII Div 1 for unfired pressure vessels for 200 psi working pressure, and shall be equipped with inlet and outlet connections, valved drain connection, minimum 6 inch dial pressure gauge, pop safety valves, and regulator connections.

2.3.2 Electrical controls

Electrical control devices shall be rated at [120] [24] volts and shall be connected as specified in Section 16415 ELECTRICAL WORK, INTERIOR.

2.3.3 Water Temperature Controller

****

NOTE: If hot water boilers are not utilized, the following paragraph will be deleted. Consideration will be given to the utilization of outside air reset controls. Outside air reset control is typically used for boilers whose primary loads are due to space heating applications. Information on outdoor air reset controls for space heating application is located in section 15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS and TM 5-815-3. Consideration will be given to the use of control based on return water temperature rather than supply water temperature.
****

The controller shall be of sturdy construction and shall be protected against dust and dampness. The thermostatic element shall be inserted in a separable socket installed [in the upper part of the boiler near the water outlet] [in the boiler return piping]. [Fixed position (on-off) and three position (high-low-off) controller shall operate on a 10 degree F differential over an adjustable temperature range of approximately 140 to 220 degrees F.] [Modulating controllers shall control the fuel burning equipment to maintain set boiler water temperature within 2 percent.] [Controller shall be furnished with necessary equipment to automatically adjust the setting to suit the outside weather conditions. The outside air reset controller shall be operated in such a manner that the operating temperatures required by the boiler manufacturer are not compromised.]

2.3.4 Steam Pressure Controller

****
NOTE: If steam boilers are not utilized the following paragraph will be deleted.
****

The controller shall be of sturdy construction and shall be protected against dust and dampness. The sensing elements of the steam controller shall be in direct contact with the steam. [Fixed position (on-off) and three position (high-low-off) type controllers shall operate on a 1 pound differential over a pressure range of 0 to 15 psig.] [Modulating controllers shall automatically maintain, within 2 percent, the desired steam pressure by regulating the burner.]

2.3.5 Boiler Plant Master Controller

****
NOTE: If only one boiler is utilized, the following paragraph will be deleted. A master controller will be provided for applications involving multiple boilers and for boilers arranged in a modular configuration.
****

A boiler plant master controller, sensitive to a [temperature transmitter in the return water header for the boiler] [steam pressure transmitter in the boiler steam discharge header] shall be furnished to provide anticipatory signals to all boiler controllers. Boiler controllers shall react to anticipatory signals from the plant master controller as necessary in response to the boiler [temperature] [pressure] indication to maintain the preset [temperature] [pressure]. An automatic-manual switch shall be provided to allow the sequence of boiler loading to be varied to distribute equal firing time on all boilers in the plant. The plant master controller shall load the boilers one at a time as the plant load increases.

2.3.6 Boiler Combustion Controls and Positioners

****

NOTE: A pilot is required for all oil fired boilers over 875 kW (3,000,000 Btuh). However, a pilot is recommended for all fired boilers.

Select between fixed rate (on-off), three position (high-low-off), and modulating controls. Combustion controls will be fixed-rate, on-off for gross outputs up to 200 kW (700,000 Btuh); high-low-off or fixed-rate on-of, depending on anticipated load profile, for gross output from 200 to 600 kW (700,000 to 2,000,000 Btuh); high-low-off or modulating, depending on anticipated load profile, for gross output from 600 to 12000 kW (2,000,000 to 4,000,000 Btuh); modulating for gross outputs above 1200 kW (4,000,000 Btuh). Modular boilers will be fixed-rate on-off for each module. Delete inappropriate paragraphs.

****

a. [Gas] [Combination gas-oil fired] boiler units shall be provided with [fixed rate (on-off)] [three position (high-low-off)] [modulating] combustion controls with gas pilot or spark ignition. Modulating controls shall be provided with a means for manually controlling the firing rate.

b. Oil fired boiler units shall be provided with [on-off] [high-low-off] [modulating] combustion controls with [direct electric spark ignition system] [spark ignited [No. 2 oil] [natural gas] [liquified petroleum gas] pilot]. Modulating controls shall be provided with a means for manually controlling the firing rate.

c. Modulating control function shall be accomplished using positioning type controls. Air flow ratio and fuel control valve shall be controlled by relative positions of operative levers on a jackshaft responding to a [water temperature controller] [steam pressure controller]. Positioning type combustion control equipment shall include draft controls with synchronized fuel feed and combustion air supply controls, while and shall maintain the proper air/fuel ratio. The desired furnace draft shall be maintained within 0.01 inch of water column.

d. [Fixed rate on-off] [High-low-off] controls for boilers with capacities up to 600 kW (2,000,000 Btuh) shall use a [water temperature controller in a temperature well in direct contact with the water] [steam pressure controller in direct contact with the steam].

2.3.7 Combustion Safety Controls and Equipment

****

NOTE: Provide feed water regulator with low-water cutoff on close coupled boilers (i.e. short supply and return lines with low pick-up losses) under 1200 kW (4,000,000 Btuh) gross output with no process loads. Provide pump controller with low-water cutoff for all other boilers. Low-water cutoff will require a manual reset unless a supplementary low-water cutoff is provided. A supplementary low-water cutoff is required for boilers utilizing a pumped condensate return system. State and local codes may also require supplementary low-water cutoffs. When a supplementary low-water cutoff is provided, it will require manual reset and the initial low-water cutoff will not require manual reset.

****

Combustion safety controls and equipment shall be UL listed, microprocessor-based distributed process controller. The system shall include mounting hardware, wiring and cables, and associated equipment. The controller shall be mounted completely wired, programmed, debugged, and tested to perform all of its functions. The controller shall process the signals for complete control and monitoring of the boiler. This shall include maintaining boiler status, starting and stopping all control functions, sequencing control functions and signaling alarm conditions. The program shall be documented and include cross references in description of coils and contacts. Microprocessor shall be able to perform self diagnostics and contain a message center to provide operator with status and failure mode information. Controllers for each boiler shall be mounted on a separate, free standing panel adjacent to the boiler or for packaged boilers on the boiler supporting structure. Control systems and safety devices for automatically fired boilers shall conform to ASME CSD-1. Electrical combustion and safety controls shall be rated at 120 volts, single phase, 60 Hz and shall be connected as specified in Section 16415 ELECTRICAL WORK, INTERIOR. A 4 inch diameter alarm bell shall be provided and shall be located where indicated or directed. The alarm bell shall ring when the boiler is shut down by any safety control or interlock. Indicating lights shall be provided on the control panel. A red light shall indicate flame failure, and a green light shall indicate that the main fuel valve is open. The following shutdown conditions shall require a manual reset before the boiler can automatically recycle:

a. Flame failure.

b. Failure to establish pilot flame.

c. Failure to establish main flame.

d. [Low-water] [supplementary low-water] cutoff.

e. [High temperature cutoff] [High pressure cutoff].

2.3.7.1 Low-water Cutoff

****

NOTE: If state or local codes or regulations

require a second cutoff, a separate supplementary low-water cutoff of the float type or electrode type may be provided. Delete supplementary low-water cutoff, if second cutoff is not required. Delete feedwater regulator and pump controller for water heating systems.

****

Low water cutoff shall be float actuated switch or electrically actuated probe type low-water cutoff. Float chamber shall be provided with a blow-down connection. Cutoff shall cause a safety shutdown and sound an alarm when the boiler water level drops below a safe minimum level. A safety shutdown due to low water shall require manual reset before operation can be resumed and shall prevent recycling of the burner. The cutoff shall be in strict accordance to the latest version of code,ASME CSD-1 Controls and Safety Devices for Automatically Fired Boilers.

a. Feedwater Regulator with Low-Water Cutoff: Regulator shall be an approved design sized for the application. A regulator shall be provided for each boiler. The feeder shall be so arranged that water will be fed to the boiler automatically when the water level in the boiler drops below a preset point and will actuate the alarm bell when the water level reaches the low danger point. The boiler feeder shall be arranged so that the burner and forced-draft fan will stop whenever the water level drops below a preset danger point. The boiler feeder shall be constructed so that the feedwater valve and seat are isolated from the float chamber to prevent overheating of the feed water and precipitation of scale on either the valve or seat. Each float mechanism, valve, and seat shall be constructed of an approved, durable, corrosion-resistant steel alloy. Valve seats shall be removable and renewable. The regulator shall be equipped with a large, self-cleaning strainer. The drain valve on the regulator shall be the gate or other straight-through type.

b. Pump Controller with Low-Water Cutoff: Controller shall be a design approved by the boiler manufacturer. A pump controller shall be provided for each boiler which is used for space heating and process steam loads or long distribution lines. Pump controller shall control the operation of the burner, forced-draft fan, and pump. Pump controller and low-water cutoff shall have a float-operated mercury switch arranged to start and stop the pump at preset boiler water levels. If the water level in the boiler reaches the low danger point, a second mercury switch shall shut down the burner and actuate the alarm bell.

c. Supplementary Low-Water Cutoff: Supplementary low-water cutoff of the [electrically operated probe type] [float activated type] shall be provided in addition to the low-water cutoff required above on each boiler. Supplementary low-water cutoff shall be mounted directly in the boiler shell and shall be set below the low-water cutoff required above.

2.3.7.2 Water Flow Interlock

****

NOTE: Delete this paragraph if a hot water boiler is not utilized.

****

Hot water boiler limit controls shall be provided to include protection for low boiler water flow and high boiler water temperature. The limit controls shall be interlocked with the combustion control system to effect boiler alarm and shutdown. The controls shall not allow boiler startup unless hot water flow is proven.

2.4 PUMPS

2.4.1 Fuel Oil Pumping and Heating Sets

****

NOTE: This paragraph may not be needed if the fuel does not require heating. This paragraph should be coordinated with section 13202 FUEL STORAGE SYSTEMS and any burner mounted pump. Select type I: simplex unit or type II duplex unit. Indicate the design requirements of filter/basket strainer located ahead of electric oil heater in order to match characteristics of fuel oil to be utilized. Select single filter/basket strainer for boilers below 60 kW (200,000 Btuh).

****

The integrated, shop-fabricated oil pumping and heating set shall be [simplex] [duplex] and be UL approved. Two positive displacement oil meters shall be provided. One meter shall be located on the fuel supply line. The other meter shall be located on the fuel return line. Each set shall include an electric oil heater of adequate capacity to heat the specified fuel oil to ignition temperature at low boiler load until enough [hot water] [steam] is generated to operate the heat exchanger. The electric heater shall be controlled by magnetic starter with a manually-operated On-Off switch in series with a thermostatic control. When oil temperature is raised to proper level and maintained by the [hot water] [steam] heater, the electric heater shall be disconnected automatically by the thermostatic control. Fuel pumps shall be electric-motor-driven. Each pump shall have the capacity of not less than [_____] gpm at a discharge pressure of [_____] psig with a suction lift of 15 feet. A [duplex] [single] filter/basket strainer system shall be installed ahead of the electric oil heater and final discharge filter/strainer system.

2.4.2 Hot Water and Boiler Circulating Pumps

****

NOTE: If separate pumps are not needed to provide water flow to the boilers, delete the requirement for boiler circulating pumps. The flow switch or pressure switch will only be needed for the pump which provides flow through the boiler. Pipe supported pumps are typically available up to 1.49 kw (2HP). Closed-coupled pumps are typically available up to 3.72 kw (5HP).

****

Circulating pumps for hot water shall be electrically driven single-stage centrifugal type and have a capacity not less than indicated. [Boiler circulating pumps shall be supported [on a concrete foundation with a cast iron or structural steel base] [or] [by the piping on which installed] and shall be [closed-coupled shaft] [or] [flexible-coupled shaft]. The boiler circulating pumps shall be [horizontal split case] [vertical split case] type]. [Hot water circulating pumps shall be supported [on a concrete foundation with a cast iron or structural steel base] [or] [by the piping on which installed] and shall have a [closed-coupled shaft] [or] [flexible-coupled shaft]. The hot water circulating pumps shall be [horizontal split case] [vertical split case] type]. The pump shaft shall be constructed of corrosion-resistant alloy steel, sleeve bearings and glands of bronze designed to accommodate a mechanical seal, and the housing of close-grained cast iron. Pump seals shall be capable of withstanding 240 degrees F temperature without external cooling. The motor shall have sufficient power for the service required, shall be of a type approved by the manufacturer of the pump, shall be suitable for the available electric service, and shall conform to the requirements of paragraph ELECTRICAL EQUIPMENT. Each pump suction and discharge connection shall be provided with a pressure gauge as specified. The [boiler] [hot water] circulating pump discharge heater shall be provided with a [flow switch] [pressure switch]. [Flow switch unit shall be a self-contained swinging vane type to indicate fluid flow.] [Pressure switch unit shall be a self-contained snap action type to indicate fluid pressure.] Switch shall be a SPDT with 120-volt, 15-ampere rating.

2.4.3 Condensate Pumping Unit

****

NOTE: If steam is utilized, only one type of condensate return unit will be required; delete either the condensate pumping unit or the vacuum pumping unit. Delete this paragraph if hot water is utilized.

****

Each pump shall have a capacity not less than that indicated when discharging against the specified pressure. The minimum capacity of the tank shall be as indicated. The condensate pumping unit shall be the [single] [duplex] [horizontal shaft] [vertical shaft] type as indicated. The unit shall consist of [one pump] [two pumps] with electric motor drive, and a single receiver, all mounted on a suitable cast-iron or steel base. The motor may be mounted on the top of the receiving tank. Pump shall be the centrifugal or turbine type, bronze-fitted throughout, with impellers of bronze or other approved corrosion-resisting metal. Pump shall be free from air binding when handling condensate of temperatures up to 200 degrees F. Pump shall be directly connected to suitable drip-proof enclosed motors. Receiver shall be cast iron or not less than 3/16 inch thick black iron or steel and shall be provided with all the necessary reinforced threaded openings, including condensate return, vent, overflow, and pump suction connections. Inlet strainer shall be provided either integral in the tank or separate in the inlet line to the tank. Vent pipe shall be galvanized steel, and the fittings shall be galvanized malleable iron. Vent pipe shall be extended through the roof and shall be properly flashed. The pump, motor, and receiving tank may be mounted on a single base with the receiver piped to the pump suctions. A gate valve and check valve shall be provided in the discharge connection from each pump and a strainer and gate valve shall be provided in the suction line to each pump except where pumps are directly mounted on top of the receiver.

2.4.3.1   Controls for Space Heating Steam Loads Only

****

NOTE: For loads where space heating is only part of the steam load, delete this paragraph.

****

An enclosed float switch complete with float mechanisms shall be installed in the head of the receiver. Each condensate pump shall be controlled by a float switch which shall automatically start the motor when the water in the receiving tank reaches the high level and stop the motor when the water reaches the low level. The motors shall be provided with magnetic across-the-line starters equipped with general-purpose enclosures and three-position, "Manual-Off-Automatic" selector switches in the cover. Automatic alternator shall be provided for duplex units.

2.4.3.2   Space Heating and Steam Loads or Distribution Lines

****

NOTE: For space heating loads only, delete this paragraph.

****

The condensate pump shall be provided with an approved float-actuated valve or water feeder in the cold-water makeup connection either external to or integral with the receiver. Where a de-aerating feedwater heater is not included, the condensate pumping unit shall be controlled automatically by a pump controller with low-water cutout on each boiler. The pump controller and low-water cutout shall have two float-operated mercury switches arranged to start and stop the condensate pump at preset boiler water levels. One switch shall control the operation of the condensate pump by starting the pump when the water in the boiler reaches a preset low level and by stopping the pump when the water in the boiler rises to a preset high level. The second switch shall ring an alarm bell and simultaneously shut down the burner. Relays shall be provided if necessary. A minimum 4 inch alarm bell with bell-ringing transformer shall be installed where directed. A gate valve and a check valve or a stop-check (nonreturn) valve shall be installed in the feed line between the boiler and the pump adjacent to the boiler connection. The condensate pump motor shall be provided with a magnetic, across-the-line starter equipped with thermal-overload protection conforming to the requirements of paragraph ELECTRICAL EQUIPMENT. Where two or more boilers are provided, a pump controller and low-water cutout shall be installed at the normal waterline of each boiler. An automatic feed valve shall be installed in the feed line to each boiler. When any boiler requires water, the pump controller shall open the feed valve by actuating an end switch which, in turn, operates the condensate pump. When the normal water level is restored, the pump controller shall close the feed valve, and the end switch of the valve shall stop the condensate pump.

2.4.3.3   Rating and Testing

The pump manufacturer shall submit a certified test report covering the actual test of the unit and certifying that the equipment complies with the indicated requirements.

2.4.4   Vacuum Pumping Unit

****
NOTE: Delete this paragraph if hot water is utilized.
****

The vacuum pumping unit shall be a combination air removal and condensate return unit consisting of [a single pump, electric motor, and receiving tank] [pumps, electric motors, and other functioning parts in duplicate and a single receiving tank] as indicated. Two interconnected single units will be acceptable in place of a duplex unit. The unit shall be arranged for automatic operation. Where duplicate pumps are used, one pump shall serve as a standby. Where it is standard with the manufacturer, separate pumps may be used for air removal and condensate return if both pumps are mounted on a common receiver. The receiver shall be constructed of cast iron, or of not less than 3/16 inch thick black iron or steel. The pumping unit shall be bronze fitted throughout with bronze shafts or with shafts protected by bronze sleeves. Pumps, motors, and receiver shall be mounted on a single base and provision shall be made for catching the drip from the stuffing boxes. Accessories shall consist of a compound gauge, a pressure gauge inlet strainer, thermometer, water level gauge with stopcocks, adjustable vacuum relief valve, air discharge and condensate discharge check valves, and companion flanges for all flanged connections. The discharge line from each pump shall be provided with a nonslam check valve and a globe valve. Each motor shall have a dripproof-type enclosure. Fully automatic controls shall be provided for each pump motor. Controls shall consist of a float in the receiving tank, a float switch, an adjustable vacuum switch, an automatic, magnetic, across-the-line type starter with general-purpose enclosure, and a three-position selector switch in the cover. The selector switch shall provide for ["Automatic," "Float," "Vacuum,"] ["Automatic," "Float,"] and "Continuous" operation of the pump.

2.5 COLD WATER CONNECTIONS

Connections shall be provided which includes consecutively in line a strainer, backflow prevention device, and water pressure regulator in that order in the direction of the flow. The backflow prevention device shall be provided as indicated and in compliance with Section 15400, PLUMBING, GENERAL PURPOSE. Cold water fill connections shall be made to the water supply system as indicated. Necessary pipe, fittings, and valves required for water connections between the boiler and cold water main shall be provided as shown. The pressure regulating valve shall be of a type that will not stick or allow pressure to build up on the low side. The valve shall be set to maintain a terminal pressure of approximately,lately 5 psi in excess of the static head on the system and shall operate within a 2 psi tolerance regardless of cold water supply piping pressure and without objectionable noise under any condition of operation.

2.6 RADIATORS AND CONVECTORS

Radiators, convectors and associated equipment shall be in accordance with Section [15556 FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS] [15562 HEATING AND UTILITIES SYSTEMS, CENTRAL STEAM].

2.7 RADIANT FLOOR HEATING SYSTEMS

****
NOTE: Delete this paragraph if radiant floor heating systems are not required.

Although this specification deals with heating water produced by boilers, other sources of heat such as solar, domestic water heaters, waste heat, or heat pumps may also be used for radiant floor heating.

The radiant floor heating system should be designed in accordance with the latest edition of the ASHRAE Systems and Equipment Handbook, HYI-400, and the Radiant Panel Association's (RPA) Standard Guidelines for the Design and Installation of Residential Radiant Panel Heating Systems.

All pipe layouts, zones, pipe sizes, and pump sizes should be clearly shown on the drawings. The designer should provide a cross sectional detail of the integrated floor and piping system that clearly shows the floor design. Floor insulation, floor coverings, floor load bearing characteristics, and manifold access panel should be coordinated with the architect and structural engineer. The method of insulating the floor is different from typical construction. If the insulation is not properly designed, the system will not work.

The drawings should also address the desired control sequence for the radiant heating system. The drawings should indicate which loops will require temperature control, in order for the manufacturer to provide a proper manifold. Various control strategies can be found in HYI 400 and the RPA standard guideline for the Design and Installation of Residential Radiant Panel Heating Systems. The control sequence should consider the required circulation of water through the boiler. High mass radiant floor heating systems do not typically respond quickly to a change in load due to the thermal mass of the floor. Therefore, night setback control is not feasible for high mass floor radiant heating systems, unless long durations of unoccupied spaces occur such as in a chapel.

Radiant floor heating systems use lower water temperatures than standard convection heating. Therefore, the boiler may experience a water temperature that is lower than recommended by the boiler manufacturer. If this occurs due to the design and selection of boiler, a mixing valve or other control devices should be provided to maintain the recommended water temperature for the boiler.

Several floor designs can be used for radiant heating. The following examples indicate a few possibilities:

Slab-on-grade: typical concrete floor system with tubing imbedded in concrete.

Thin-slab system: tubing imbedded in a thin light weight concrete on top of a wooden sub-floor.

Above floor plate system: tubing installed in channels with reflective metal barriers above a wooden sub-floor. The tubing is then covered with thin sheets of plywood.

Below floor plate system: the tubing is installed below the wooden sub-floor using reflective metal barriers.

Below floor suspended tube system: the tubing is suspended within the interstitial space between a wooden sub-floor and insulation. (Seldom used due to higher water temperature requirements).

Below floor staple-up system: the tubing is stapled to the underside of a wooden sub-floor. This system is available; however, the below floor plate system is more energy efficient.

If outdoor air is required for ventilation, a separate make-up air system should be installed.

Per the Standard Mechanical Code, the temperature of these heating systems should not exceed an operating temperature of 60 degrees C (125 degrees F), when the piping is used in gypsum assemblies.
****

The radiant floor heating system shall include all piping, manifolds, valves, pumps, expansion tank, pressure relief valves, and controls to provide a complete and operational heating system.

2.7.1 Tubing

The tubing material shall comply with ASTM F 876. The pipings shall be provided with a factory applied oxygen barrier with a diffusion rate that does not exceed 0.1 grams per cubic meter per day. The piping shall be rated at 100 psi and 180 degrees F.

2.7.2 Joints

The manifold manufacturer shall be consulted to determine the proper joint for connection of tubing to the manifold. The joints required to connect the tubing to the manifold shall be compression type fittings using crimp rings, a combination of inserts and O-rings, gripper type fittings using a retainer ring and O-rings, or as otherwise recommended by the manifold and tubing manufacturer.

2.7.3 Manifold

The design and construction of the manifold shall be compatible with the tubing manufacture's requirements. The piping manifold material shall be compatible with the piping material. The manifold shall be capable of providing the number of circuits as indicated on the drawings. The manifold shall be suitable for an operating pressure of 100 psi and 180 degrees F. Balancing valves shall be provided for each circuit. Isolation valves shall be provided for each supply and return connection. Each manifold shall be provided with an air vent. the manifold shall allow for the measurement of temperature for each circuit. The manifold shall be provided with all required mounting hardware.

2.8   HEATING AND VENTILATING UNITS

Heating and ventilating units and associated equipment shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

2.9   AIR HANDLING UNITS

Air handling units and associated equipment shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

2.10   FITTINGS AND ACCESSORIES

Boiler fittings and accessories shall be installed with each boiler in accordance with ASME BPV IV, unless otherwise specified.

2.10.1   Soot Blowers

****

NOTE: Soot blowers will normally be required on large water tube units burning No. 5 or 6 fuel oil. Manufacturers of boilers should be consulted to determine if soot blowers are applicable for the design contemplated. Small units are usually manually cleaned.

****

Where indicated, each boiler shall be provided with soot blowers using [compressed air] [steam] as the blowing medium. The soot blower system shall be the automatic sequencing and intermittent puff type. The soot blower units shall be sequenced automatically using successive steps by their controller, each step involving no more than a 10 psi drop in air pressure at the receiver. After one unit is operated in successive steps through its cycle, the controller shall shift the operation to the second soot blower unit, and so on, until all units on that boiler have been operated, after which the controller shall be shut down automatically by the sequence controls. The soot blower heads shall have elements of suitable material for the highest temperatures encountered in the boiler. The sequence timer shall have provision for manual selection of the soot blower units to be used. Soot blower system for oil fired boilers shall conform to NFPA 8501.

2.10.1.1   Air Compressor Unit

The air compressor unit shall conform to ASME PTC 10 except as specified otherwise. Compressor speed shall not exceed 900 rpm. Motor speed shall not exceed 1750 rpm. The service air requirements shall be as indicated with receivers sized as indicated. The units shall be suitable for heavy-duty service (soot blowing). The compressors shall be simplex type, single-stage, double-acting, with water-jacketed cylinder, fitted with intake and discharge valves of the lightweight feather, disc or plate type, and shall be provided with necessary controls, water-cooled aftercooler, moisture separator, drive, receiver, relief valves, and cooling water controls as required. The compressor air intake shall be provided with an air suction filter/silencer suitable for outdoor installation. The filter shall have a collection efficiency of 99 percent of particles larger than 10 microns. The filter body and media shall withstand a pressure of 125 psi. The aftercooler shall be the shell-and-tube type designed for air flow through the tubes with steel shell internal baffle plates. The cooling capacity of the after cooler shall be sized for the total capacity of the compressor. The moisture separator shall be provided with an automatic water discharge trap and level gauge. Cooling water controls for regulating compressor cylinder water temperature and after-cooler water temperature shall be thermostatic valve type and shall be installed with a three-valve bypass in the water outlet lines ahead of open sight drain funnels. The compressor shall be equipped with adjustable, pressure type unloader controls suitable for continuous compressor operation.

2.10.1.2 Air Receiver

The air receiver shall be a vertical type constructed in accordance with ASME BPV VIII Div 1 for unfired pressure vessels for 200 psi working pressure, and shall be equipped with flanged inlet and outlet connections, valved drain connection, minimum 6 inch dial pressure gauge, pop safety valves, and regulator connections.

2.10.2 Continuous Emissions Monitoring

****

Emerging flue gas flow monitor technologies are available. The traditional differential pressure technique specified used familiar equipment that can be maintained by plant personnel. This type of measurement device has reliably satisfied regulatory requirements. The possible use of other technologies should include a thorough investigation of flue gas flow monitor regulatory requirements and inhouse maintenance capabilities.

****

a. Continuous Emissions Monitoring System (CEMS) equipment shall be provided as a system by a single manufacturer. A CEMS, meeting the requirements of applicable federal, State of [_____] and local regulations, shall be provided for each boiler in accordance with manufacturer's recommendations and under the direct supervision of the CEMS equipment manufacturer. Before acceptance of the installation, the Contracting Officer shall be furnished a written test report which provides documentation that the CEMS equipment passed factory and field certification test required by federal, state, and local regulations.

b. The reported data shall include [sulfur dioxide (SO2)] [oxides of nitrogen (NOX)] [carbon dioxide (CO2)] [and] [particulate matter (PM)] and other information required by Federal, state, and local regulations. SO2 reporting shall be based on [analyzer measurement] [fuel flow and percent sulfur calculation]. Nitrous oxides, carbon dioxide and particulate matter reporting shall be based on analyzers.

c. The CEMS equipment shall include the central processing unit, printer, hard disk drive, and floppy disk drive. The floppy disk drive shall function as a recorder. The manufacturer shall provide the software to generate the required reports in a format acceptable to the Federal, state and local regulatory agencies. The operator interface to the CEMS equipment shall be via CRT screen.

2.10.2.1 Gaseous Emission Monitors

Extractive or in situ gaseous monitors shall be provided. A combination of extractive and in situ monitors is not acceptable. Gas monitors shall include automatic calibration checks. An alarm horn and annunciator shall be provided to alarm when any monitor parameter is out of range or a gaseous monitor malfunctions. The surfaces that are exposed to the corrosive gas of the boiler shall be constructed of noncorrosive materials such as 316 SS, teflon or hastelloy.

a. In situ monitor shall be mounted on the ductwork at the location [shown on the plans] [recommended by the manufacturer]. The situ system shall not be affected by the presence of particulate matter in the flue gas.

b. Extractive systems shall be [wet] [dry] [diluted]. Analyzing equipment for the extractive system shall be located in a walk-in cabinet. The equipment shall be arranged to provide access for maintenance. Extractive system sampling between the probes and the analyzers shall be heat traced to maintain the temperature recommended by the manufacturer when the ambient temperature is [_____] degrees F. Probes shall be mounted on the ductwork at the location [shown on the plans] [recommended by the manufacturer].

2.10.2.2 Flue Gas Flow Monitor

Flue gas flow monitor shall utilize the pitot tube principle to measure the flow. The probe shall be an across-the-duct-average pitot tube and shall be designed and located to obtain representative measurement. Differential pressure transmitters shall be used to sense the difference between he static and total pressure of the flowing gas steam. Calibrations shall be stable. Lines shall be arranged to prevent collection of condensate. A purge system shall be provided as required to keep the pitot pressure taps clear.

2.10.2.3 Particulate Matter Monitor

Particulate matter (opacity) monitor based on the principle of transmissometry shall be provided. The transmissometer shall include automatic simulation of zero opacity and upscale check of calibration while the boiler is in service without dismounting the unit. The calibration check shall include analyzer internal circuitry and electronic circuitry. An alarm horn and annunciator shall be provided to annunciate excess opacity and any system malfunction. Units shall be provided with fans to keep the sending and receiving lenses pressurized and blown clean at all times.

2.10.2.4 Wiring

The CEMS equipment shall be provided with plug-in prefabricated cable for interconnection between components. Power supply to the equipment shall be 2-wire, 120 volt nominal or less, 60 Hz, with one side grounded. Electrical devices shall be connected as specified in Section 16415 ELECTRICAL WORK, INTERIOR.

2.10.3 Tankless Water Heater

****

NOTE: If the system will not be used to heat domestic hot water delete this paragraph.

****

A seamless copper immersion type tankless water heater of the specified capacity shall be installed in the boiler. The heater shall be equipped with an approved water-tempering valve which shall be set to supply hot water at approximately 150 degrees F. Instead of the immersion type coil, an approved external shell and tube type or plate type heat exchanger may be installed per Section 15556 FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS.

2.10.4 Conventional Breeching and Stacks

****

NOTE: Delete this paragraph for condensing boilers.

****

2.10.4.1 Breeching

Each boiler shall be connected to the stack or flue by breeching constructed of black steel sheets not less than 0.0478 inch thick nor less than thickness of stack, whichever is larger. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. The clear distance between any portion of the breeching surface and any combustible material shall not be less than that specified in NFPA 211. Joints and seams shall be securely fastened and made airtight. Suitable hinged and gasketed cleanouts shall be provided, which will permit cleaning the entire smoke connection without dismantling. Flexible-type expansion joints shall be provided as required and shall not require packing.

2.10.4.2 Stacks

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NOTE: Frequently boiler outlets are designed to support no more than the weight of a 6 m (20 foot) stack section, when installed directly above the boiler outlet. Ensure that the stack is properly supported.

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[Individual stub stacks shall extend above the roof to the heights indicated. Individual stub stacks shall be [20] [_____] feet in height when assembled on the boiler and measured from the ground line. Stack section shall be sheet steel having a thickness of not less than 0.0972 inch.] [Prefabricated double wall stacks system shall extend above the roof to the height indicated. The stacks shall be [20] [_____] feet in height when assembled on the boiler and measured from the ground line. The inner stack shall be [304 stainless steel] [316 stainless steel] having a thickness of not less than 0.035 inch. The outer stack shall be sheet steel having a thickness of not less than 0.025 inch. A method of maintaining concentricity between the inner and outer stacks shall be incorporated. The joints between the stack sections shall be sealed to prevent flue gas leakage.] A 0.3125 inch diameter hole shall be provided in the stack not greater than 6 inches from the furnace flue outlet for sampling of the exit gases. A method shall be provided to seal the hole to prevent exhaust gases from entering the boiler room when samples are not being taken. Each stack shall be provided complete with rain hood. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.10.5 Direct Vents

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NOTE: Delete this paragraph if condensing boilers are not used. A conventional stack is not needed for condensing boilers due to the low exhaust air temperature. Precautions should be taken due to the acidic condition of the condensate. The location and size of the vents should be shown on the drawings. Consult NFPA 54, UL 1738, and available vendor data to design the vents. The vents can be mounted on the roof or exterior wall with proper separation. The vents should be extended above the typical snow level. Vents should be located in such a manner as to prevent vandalism and to prevent discharge of condensate across walkways.

****

Direct venting shall be used for condensing type boilers. Both the air intake and exhaust vents shall be sized and located as indicated on the drawings and as recommended by the boiler manufacturer. A separate combustion air intake vent and exhaust vent shall be provided for each boiler.

2.10.5.1 Combustion Air Intake Vent

The combustion air intake piping shall be constructed of Schedule 40 PVC per ASTM D 1784. The vent shall be suitable for the temperature at the boiler combustion air intake connection point. Each intake shall be provided complete with bird screen.

2.10.5.2 Exhaust Vent

The exhaust vent piping shall be constructed of Schedule 40 CPVC or stainless steel conforming to UL 1738 and the boiler manufacturer's recommendations. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. The exhaust vent shall be suitable for the maximum anticipated boiler exhaust temperature and shall withstand the corrosive effects of the condensate. A 0.3125 inch diameter hole shall be provided in the stack not greater than 6 inches from the boiler flue outlet for sampling of the exit gases. A method shall be provided to seal the hole to prevent exhaust gases from entering the boiler room when samples are not being taken. Each exhaust stack shall be provided complete with bird screen.

2.10.6   Expansion Tank

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NOTE: If a hot water heating system is not utilized delete this paragraph.
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The hot water pressurization system shall include a diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting the pressure increase at all components in the system to the maximum allowable pressure at those components. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank. The sizes shall be as indicated. The expansion tank shall be welded steel, constructed, tested, and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of [125] [_____] psi and precharged to the minimum operating pressure. The tank's air chamber shall be fitted with an air charging valve and pressure gauge. The tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The tank shall have lifting rings and a drain connection. All components shall be suitable for a maximum operating temperature of 250 degrees F.

2.10.7   Air Separator

External air separation tank shall be steel, constructed, tested and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of [125] [_____] psi. The capacity of the air separation tank indicated is minimum.

2.10.8   Filters

Filters shall conform to [ASTM F 872] [CID A-A-1419].

2.10.9   Foundation (Setting) Materials

2.10.9.1   Firebrick

Firebrick shall be ASTM C 27 class as recommended by boiler manufacturer.

2.10.9.2   Tile

Tile shall be ASTM C 34, Grade LBX.

2.10.9.3   Insulating Brick

Insulating brick shall comply with ASTM C 155.

2.10.9.4   Refractory Mortar

Refractory mortar shall comply with ASTM F 1097.

2.10.9.5   Castable Refractories

Castable refractories shall be ASTM C 401. The minimum modulus of rupture for transverse strength shall be not less than 600 psi after being heat soaked for 5 hours or more at a temperature in excess of 2500 degrees F.

2.10.10 Steel Sheets

2.10.10.1 Galvanized Steel

Galvanized steel shall be ASTM A 653/A 653M.

2.10.10.2 Uncoated Steel

Uncoated steel shall be ASTM A 366/A 366M, composition, condition, and finish best suited to the intended use. Gauge numbers specified refer to manufacturer's standard gauge.

2.10.11 Gaskets

Gaskets shall be nonasbestos material in accordance with ASME B16.21, full face or self-centering type. The gaskets shall be of the spiral wound type with graphite filler material.

2.10.12 Steel Pipe and Fittings

2.10.12.1 Steel Pipe

Steel pipe shall be ASTM A 53, Type E or S, Grade A or B, black steel, standard weight.

2.10.12.2 Steel Pipe Fittings

Fittings shall have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

2.10.12.3 Steel Flanges

Flanged fittings including flanges, bolts, nuts, bolt patterns, etc. shall be in accordance with ASME B16.5 class 150 and shall have the manufacturers trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105/A 105M. Flanges for high temperature water systems shall be serrated or raised-face type. Blind flange material shall conform to ASTM A 516/A 516M cold service and ASTM A 515/A 515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193/A 193M.

2.10.12.4 Welded Fittings

Welded fittings shall conform to ASTM A 234/A 234M with WPA marking. Buttwelded fittings shall conform to ASME B16.9, and socket-welded fittings shall conform to ASME B16.11.

2.10.12.5 Cast-Iron Fittings

Fittings shall be ASME B16.4, Class 125, type required to match connecting piping.

2.10.12.6 Malleable-Iron Fittings

Fittings shall be ASME B16.3, type as required to match connecting piping.

2.10.12.7 Unions

Unions shall be ASME B16.39, Class 150.

2.10.12.8   Threads

Pipe threads shall conform to ASME B1.20.1.

2.10.12.9   Grooved Mechanical fittings

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NOTE: Grooved mechanical fittings will not be allowed for steam piping or condensate piping or hot water piping above 110 degrees C (230 degrees F).
****

Joints and fittings shall be designed for not less than 125 psig] [_____] service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47, ASTM A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming to ASTM A 106, Grade B or ASTM A 53. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000, Grade No. 2CA615A15B44F17Z for circulating medium up to 230 degrees F or Grade N0. M3BA610A15B44Z for circulating medium up to 200 degrees F. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

2.10.13   Copper Tubing and Fittings

2.10.13.1   Copper Tubing

Tubing shall be ASTM B 88, ASTM B 88M, Type K or L. Adapters for copper tubing shall be brass or bronze for brazed fittings.

2.10.13.2   Solder-Joint Pressure Fittings

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18 and ASTM B 828.

2.10.13.3   Flared Fittings

Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62.

2.10.13.4   Adapters

Adapters may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.10.13.5   Threaded Fittings

Cast bronze threaded fittings shall conform to ASME B16.15.

2.10.13.6   Brazing Material

Brazing material shall conform to AWS A5.8.

2.10.13.7   Brazing Flux

Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides, and contain fluorides. Silver brazing materials shall be in accordance with AWS A5.8.

2.10.13.8   Solder Material

Solder metal shall conform to ASTM B 32 95-5 tin-antimony.

2.10.13.9   Solder Flux

Flux shall be either liquid or paste form, non-corrosive and conform to ASTM B 813.

2.10.14   Dielectric Unions

Dielectric unions shall have metal connections on both ends. The ends shall be threaded, flanged, or brazed to match adjacent piping. Metal parts of the union shall be separated so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact.

2.10.15   Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 125 psi or 150 psi service. Connectors shall be installed where indicated. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. Materials used and the configuration shall be suitable for the pressure, vacuum, and temperature medium. The flexible section shall be suitable for service intended and may have threaded, welded, soldered, flanged, or socket ends. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

2.10.16   Pipe Supports

Pipe supports shall conform to MSS SP-58 and MSS SP-69.

2.10.17   Pipe Expansion

2.10.17.1   Expansion Loops

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NOTE: Whenever possible, expansion loops, offsets, and bends shall be utilized instead of expansion joints to absorb and to compensate for expansion and contraction. Coordination will be made with seismic bracing. Seismic bracing should not interfere with thermal expansion.

****

Expansion loops and offsets shall provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. The loops and offsets shall be cold-sprung and installed where indicated. Pipe guides and anchors shall be provided as indicated.

2.10.17.2 Expansion Joints

Expansion joints shall provide for either single or double slip of the connected pipes, as required or indicated, and for not less than the transverse indicated. The joints shall be designed for a [hot water] [steam] working pressure not less than [_____] psig and shall be in accordance with applicable requirements of EJMA Stds and ASME B31.1. End connection shall be flanged. Anchor bases or support bases shall be provided as indicated or required. Sliding surfaces and water wetted surfaces shall be chromium plated or fabricated of corrosion resistant steel. Initial setting shall be made in accordance with the manufacturer's recommendations to compensate for an ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer, but in any case shall not be more than 5 feet from expansion joint, except in lines 4 inches or smaller guides shall be installed not more than 2 feet from the joint. Service outlets shall be provided where indicated.

a. Bellows-type joints shall be flexible, guided expansion joints. The expansion element shall be stabilized corrosion resistant steel. Bellows-type expansion joints shall conform to the applicable requirements of EJMA Stds and ASME B31.1 with internal lines. Guiding of piping on both sides of expansion joint shall be in accordance with the published recommendations of the manufacturer of the expansion joint. The joints shall be designed for the working temperature and pressure suitable for the application but shall not be less than 150 psig.

b. Flexible ball joints shall be constructed of alloys as appropriate for the service intended. The joints shall be threaded, grooved, flanged, or welded end as required and shall be capable of absorbing the normal operating axial, lateral, or angular movements or combination thereof. Balls and sockets shall be polished, chromium-plated when materials are not of corrosion-resistant steel. The ball type joint shall be designed and constructed in accordance with ASME B31.1 and EJMA Stds. Flanges shall conform to the diameter and drilling of ASME B16.5. Molded gaskets shall be suitable for the service intended.

c. Slip type expansion joints shall be EJMA Stds and ASME B31.1, Class 1 or 2. Type II joints shall be suitable for repacking under full line pressure.

2.10.18 Valves

Valves shall be Class 125 and shall be suitable for the application. Grooved ends per AWWA C606 may be used for water service only. Valves in nonboiler external piping shall meet the material, fabrication and operating requirements of ASME B31.1. The connection type of all valves shall match the same type of connection required for the piping on which installed.

2.10.18.1 Gate Valves

Gate valves 2-1/2 inches and smaller shall conform to MSS SP-80 bronze rising stem, threaded, solder, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70 cast iron bronze trim, outside screw and yoke, flanged, or threaded ends.

2.10.18.2 Globe Valves

Globe valves 2-1/2 inches and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Globe valves 3 inches and larger shall conform to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

2.10.18.3 Check Valves

Check valves 2-1/2 inches and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Check valves 3 inches and larger shall conform to MSS SP-71, cast iron, bronze trim, flanged, or threaded ends.

2.10.18.4 Angle Valves

Angle valves 2-1/2 inches and smaller shall conform to MSS SP-80 bronze, threaded, soldered, or flanged ends. Angle valves 3 inches and larger shall conform to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

2.10.18.5 Ball Valves

Ball valves 1/2 inch and larger shall conform to [MSS SP-72] [or] [MSS SP-110], ductile iron or bronze, threaded, soldered, or flanged ends.

2.10.18.6 Plug Valves

Plug valves 2 in. and larger shall conform to MSS SP-78. Plug valves smaller than 2 in. shall conform to ASME B16.34.

2.10.18.7 Grooved End Valves

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NOTE: Grooved end valves will not be allowed for steam piping.

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Valves with grooved ends per AWWA C606 may be used if the valve manufacturer certifies that their performance meets the requirements of the standards indicated for each type of valve.

2.10.18.8 Balancing Valves

Balancing valves shall have meter connections with positive shutoff valves. An integral pointer shall register the degree of valve opening. Valves shall be calibrated so that flow rate can be determined when valve opening in degrees and pressure differential across valve is known. Each balancing valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation. Valves shall be suitable for 250 degrees F temperature and working pressure of the pipe in which installed. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. One portable differential meter shall be furnished. The meter suitable for the operating pressure specified shall be complete with hoses, vent, and shutoff valves, and carrying case. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing.

2.10.18.9 Automatic Flow Control Valves

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NOTE: In any facility where technological and occupancy requirements indicate that load imbalances cannot be tolerated and there is a need for automatic control ensuring constant hydronic flow, the design will incorporate automatic flow-control valves indicating their location and capacity on the drawings. The required pump head will be shown on the drawings.

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In lieu of the specified balancing valves, automatic flow control valves may be provided to maintain constant flow and shall be designed to be sensitive to pressure differential across the valve to provide the required opening. Valves shall be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Valves shall control the flow within 5 percent of the tag rating. Valves shall be suitable for the maximum operating pressure of 125 psi or 150 percent of the system operating pressure, whichever is greater. Where the available system pressure is not adequate to provide the minimum pressure differential that still allows flow control, the system pump head capability shall be increased. Valves shall be suitable for 250 degrees F temperature service. Valve materials shall be same as specified for the heating system check, globe, angle, and gate valves. Valve operator shall be the electric motor type or pneumatic type as applicable. Valve operator shall be capable of positive shutoff against the system pump head. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential across the automatic flow control valve. A portable meter shall be provided with accessory kit as recommended for the project by the automatic valve manufacturer.

2.10.18.10 Butterfly Valves

Butterfly valves shall be 2-flange type or lug wafer type, and shall be bubbletight at 150 psig. Valve bodies shall be cast iron, malleable iron, or steel. ASTM A 167, Type 404 or Type 316, corrosion resisting steel stems, bronze, or corrosion resisting steel discs, and synthetic rubber seats shall be provided. Valves smaller than 8 inches shall have throttling handles with a minimum of seven locking positions. Valves 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

2.10.18.11 Drain valves

Drain valves shall be provided at each drain point of blowdown as recommended by the boiler manufacturer. Piping shall conform to ASME BPV IV and ASTM A 53.

2.10.18.12 Safety Valves

Safety valves shall have steel bodies and shall be equipped with corrosion-resistant trim and valve seats. The valves shall be properly guided and shall be positive closing so that no leakage can occur. Adjustment of the desired back-pressure shall cover the range between 2 and 10 psig. The adjustment shall be made externally, and any shafts extending through the valve body shall be provided with adjustable stuffing boxes having renewable packing. Boiler safety valves of proper size and of the required number, in accordance with ASME BPV IV, shall be installed so that the discharge will be through piping extended [to the blowoff tank] [to a location as indicated]. [Each discharge pipe for steam service shall be provided with a drip pan elbow to prevent accumulation of water on the valve. A slip joint shall be provided between drip pan elbow and riser.] [Each discharge pipe for hot water service shall be pitched away from the valve seat.]

2.10.19 Strainers

Basket and "Y" type strainers shall be the same size as the pipelines in which they are installed. The strainer bodies shall be heavy and durable, fabricated of cast iron, and shall have bottoms drilled and tapped with a gate valve attached for blowdown purposes. Strainers shall be designed for [_____] psig service and [_____] degrees F. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment screen. The screen shall be made of 22 gauge [brass sheet] [monel] [corrosion-resistant steel] with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.10.20 Pressure Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shutoff valve. Minimum dial size shall be 3-1/2 inches. A pressure gauge shall be provided for each boiler in a visible location on the boiler. Pressure gauges shall be provided with readings in Kpa and psi. Pressure gauges shall have an indicating pressure range that is related to the operating pressure of the fluid in accordance with the following table:

Operating Pressure (kPA)	Pressure Range (kPA)
519-1030	0-1400
105-518	0-690
14-104	0-210 (retard)

Operating Pressure (psi)	Pressure Range (psi)
76-150	0-200
16-75	0-100
2-15	0-30 (retard)

Operating Pressure (psi)   Pressure Range (psi)

2.10.21   Thermometers

Thermometers shall be provided with wells and separable corrosion-resistant steel sockets. Thermometers for [inlet water and outlet water for each hot water boiler] [the feedwater for each steam boiler] shall be provided in a visible location on the boiler. Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a minimum 9 inch scale. The operating range of the thermometers shall be 0-100 degrees centigrade (32 - 212 degrees Fahrenheit). The thermometers shall be provided with readings in degrees centigrade and Fahrenheit.

2.10.22   Air Vents

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NOTE: Air vent locations will be indicated on drawings; distinguish between manual and automatic air vents.

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2.10.22.1   Manual Air Vents

Manual air vents shall be brass or bronze valves or cocks suitable for the pressure rating of the piping system and furnished with threaded plugs or caps.

2.10.22.2   Automatic Air Vents

Automatic air vents shall be 3/4 inch quick-venting float and vacuum air valves. Each air vent valve shall have a large port permitting the expulsion of the air without developing excessive back pressure, a noncollapsible metal float which will close the valve and prevent the loss of water from the system, an air seal that will effectively close and prevent the re-entry of air into the system when subatmospheric pressures prevail therein, and a thermostatic member that will close the port against the passage of steam from the system. The name of the manufacturer shall be clearly stamped on the outside of each valve. The air vent valve shall be suitable for the pressure rating of the piping system.

2.10.23   Steam Traps

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NOTE: The design engineer, when designating steam using equipment or special steam applications, will indicate the type of steam trap required in accordance with the following data:

a. Inverted Bucket Traps: This type of trap continuously vents air and carbon dioxide at steam temperature and is recommended for modulating loads. The bucket floats on steam to close the outlet and sinks into condensate to open the condensate outlet. Any trapped air is discharged first into the

condensate return line and is followed by condensate discharge. This type of trap has the longest life on systems under modulated control. When large amounts of air are anticipated, an external thermostatic air vent should be installed on a line bypassing the trap to bleed air from the steam line and discharge it to the condensate return line. This system will give optimum performance at low steam pressures with maximum dependability. These traps will handle condensate from fan coil units where condensate must be lifted to return lines located above the equipment. They operate best at near full load conditions where loads do not vary over a wide range. Before operation, traps must be primed by filling them with water.

b. Vertical Open-Top Bucket Trap: Trap construction is more complex than inverted bucket type but is suitable for applications having wide variation of load and pressure and is recommended for constant pressure systems. Bucket sinks into condensate when condensate reaches top of trap and the discharge port opens. After discharge, the bucket floats on incoming condensate keeping the discharge port closed.

c. Impact-Operated Traps: These traps depend on steam velocity to keep the disc closed. As steam velocity decreases, the disc lifts off the seat and allows flow of condensate. These traps allow some steam leakage and do not vent air at low pressure. They are not recommended for service lower than 69 kPa (10 psig) or where back pressure may exceed 50 percent of inlet pressure. These traps are less expensive and have poor performance in the presence of dirt.

d. Thermostatic Traps: These traps are bellows-actuated and contraction of bellows at a few degrees below saturated steam pressure allows condensate air and noncondensable gases to be discharged. As steam reaches the bellows the expansion of the bellows closes the discharge port. These traps can also be utilized to vent air from a steam system and can be used in conjunction with an inverted bucket steam trap previously described.

e. Float and Thermostatic Trap: These traps provide optimum performance on modulating systems at lowest first cost. Where steam pressures modulate down to zero, large amounts of air may be liberated. They are ideal for dripping ends of steam risers, heels of up-feed steam risers, bottoms of down-feed stem risers. These traps are also ideal for fan

coil units and unit heaters.

f. Any trap selected must be sized for the expected condensate load with an applicable safety factor applied for the particular type of equipment serviced. Manufacturer's application manuals should be consulted to assist in sizing traps. Safety factors vary from 2:1 to 10:1. An average 3:1 safety factor value will cover most applications.

g. Service life between repairs or replacement of traps may be a determining factor in the choice of traps. One manufacturer of all types of traps offers the following experience record:

Type of Trap	Average Service Life Between Replacement or Repairs
Inverted bucket traps	42 months
Float and thermostatic traps	24 months
Thermostatic traps	24 months
Impact-operated traps	19 months

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2.10.23.1 Thermostatic Traps

Thermostatic traps shall conform to the requirements of ASTM F 1139 and shall be installed in the return connection from each radiator and elsewhere as indicated. Drip traps for mains, risers, and similar lines shall be installed with a cooling leg of 5 feet of uncovered 3/4 inch pipe. The capacity of traps shall be based on a pressure differential of 2 psi. The traps shall be designed for a steam working pressure of 15 psig but shall operate with a supply pressure of approximately 2 psig. The traps shall be angle or straight-through pattern with union inlet connections as indicated. The trap bodies and covers shall be brass. Valve mechanisms and seats shall be monel, stainless steel or hard bronze and shall be removable for servicing or replacement.

2.10.23.2 Float-and-Thermostatic Traps

Float-and-thermostatic traps shall conform to the requirements of ASTM F 1139 and be designed for a steam working pressure of 15 psig but shall operate with a supply pressure of approximately 5 psig. The trap capacity shall be based on a pressure differential of 2 psig. Each float-and-thermostatic trap shall have a cast iron body and shall be provided with a hard bronze, monel, or corrosion-resisting steel valve seat and mechanism, an open- or closed-type float of brass or equally corrosion-resistant metal, and a corrosion-resisting steel thermostatic air vent, all of which can be easily removed for inspection or replacement without disturbing the piping connections. The inlet to each trap shall have a brass or stainless steel strainer, either as an integral part of the trap or as a separate item of equipment.

2.10.23.3 Inverted Bucket Traps

Inverted bucket traps shall conform to the requirements of ASTM F 1139 and be designed for a steam working pressure of 15 psig but shall operate with a supply pressure of approximately 5 psig. Each trap shall have a cast iron body and shall have a corrosion-resistant steel valve and seat and a brass or corrosion-resistant steel bucket, all of which can be easily removed for inspection or replacement without disturbing the piping connections. The inlet to each trap shall have a brass or stainless steel strainer, either as an integral part of the trap or as a separate item of equipment.

2.11 ELECTRICAL EQUIPMENT

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NOTE: Select standard efficiency for motors used less than 750 hours per year and high efficiency for motors used over 750 hours per year. The efficiency of each motor will be indicated in the equipment schedules.

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Electric motor-driven equipment shall be provided complete with motors, motor starters, and necessary control devices. Electrical equipment, motor control devices, motor efficiencies and wiring shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR. Motors which are not an integral part of a packaged boiler shall be rated for [standard] [high] efficiency service. Motors which are an integral part of the packaged boiler shall be the highest efficiency available by the manufacturer of the packaged boiler. Motor starters shall be provided complete with properly sized thermal overload protections and other appurtenances necessary for the motor control specified. Starters shall be furnished in [general purpose] [watertight] [explosion-proof, Class I, division I] enclosures. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices but not shown shall be provided.

2.11.1 Motor Ratings

Motors shall be suitable for the voltage and frequency provided. Motors 1/2 hp and larger shall be three-phase, unless otherwise indicated. Motors shall be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating on the motor.

2.11.2 Motor Controls

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NOTE: The motor controls shall be properly coordinated with Section 16415 ELECTRICAL WORK, INTERIOR. Coordinate with the electrical designer for power factors, service factors, and desired type of control.

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Motor controllers shall be provided complete with properly sized thermal overload protection. Manual or automatic control and protective or signal devices required for the operation specified and any wiring required to such devices shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Solid state variable speed controllers shall be utilized for fractional through 10 hp ratings. Adjustable frequency drives shall be used for larger motors.

2.12 INSULATION

Shop and field-applied insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.13 TOOLS

Special tools shall be furnished. Special tools shall include uncommon tools necessary for the operation and maintenance of boilers, burners, pumps, fans, controls, meters, special piping systems, and other equipment. Small hand tools shall be furnished within a suitable cabinet, mounted where directed.

2.13.1 Breeching Cleaner

A cleaner shall be provided to clean the breeching. The cleaner shall have a jointed handle of sufficient length to clean the breeching without dismantling.

2.13.2 Tube Cleaner

If a watertube boiler is being furnished, a water-driven tube cleaner with three rotary cutters and rotary wire brush complete with the necessary length of armored water hose, valves, and other appurtenances necessary for operation shall be provided. Tube cleaner and rotary brush shall be provided for each size of water tube in the boiler, with one extra set of cutters for each size cleaner. Necessary valves and fittings shall be provided to permit ready connection of the cleaner hose to a high-pressure pump for cold water supply to operate the cleaner.

2.13.3 Tube Brush

If a firetube boiler is being furnished, a tube brush, with steel bristles and jointed handle of sufficient length to clean full length of firetubes, shall be provided.

2.13.4 Wrenches

Wrenches shall be provided as required for specialty fittings such as manholes, handholes, and cleanouts. One set of extra gaskets shall be provided for all manholes and handholes, for pump barrels, and other similar items of equipment. Gaskets shall be packaged and properly identified.

2.14 FUEL OIL STORAGE SYSTEM

The fuel oil storage system shall be as specified in Section 13202 FUEL STORAGE SYSTEMS unless noted otherwise.

2.14.1 Hot-Water and Steam Coils

A [helical wound coil constructed of 1 inch seamless steel tubing] [platecoil suction bell heater constructed of carbon steel not lighter than 14 gauge] shall be provided in each tank for No. 6 fuel oil and installed around the suction end of the oil line. The coil in each tank shall have capacity to heat the fuel oil from [_____] to [_____] degrees F, during the maximum demand of all oil burners connected to the tank. The coil shall utilize [steam at [_____] psig] [hot water at [_____] degrees F] as the heating medium. The heating coil inlet and outlet connections and the fuel-oil suction and return piping connections shall be attached to the same tank manway cover. An additional manhole located above the heater shall be provided for removal of the heater as a unit.

2.15 BOILER WATER TREATMENT

****
NOTE: The chemical piping will be indicated on the drawing. Piping for external chemicals will be connected to the boiler feedwater. Piping for internal chemicals will be connected to the boiler drum. If steam is used for cooking or humidification, a separate heat exchanger will be required due to environmental constraints with the use of amines. The following items will not be required for hot water boilers: water softening system, chemical feed pumps, tanks, injection assemblies, water meters, water treatment control panel, and sequence of operation. The chemical shot feeder will not be required for steam boilers.
****

The water treatment system shall be capable of feeding chemicals and bleeding the system to prevent corrosion and scale within the boiler and piping distribution system. The water shall be treated to maintain the conditions recommended by the boiler manufacturer. Chemicals shall meet required federal, state, and local environmental regulations for the treatment of boilers and discharge to the sanitary sewer. The services of a company regularly engaged in the treatment of boilers shall be used to determine the correct chemicals and concentrations required for water treatment. The company shall maintain the chemical treatment and provide all chemicals required for a period of 1 year from the date of occupancy. Filming amines and proprietary chemicals shall not be used. The water treatment chemicals shall remain stable throughout the operating temperature range of the system and shall be compatible with pump seals and other elements of the system.

2.15.1 MakeUp Water Analysis

****
NOTE: A water analysis may be available from the user. If an analysis is not available, an analysis will be performed during the design, and appropriate data will be entered.
****

The makeup water conditions reported per ASTM D 596 are as follows:

Date of Sample	[_____]
Temperature	[_____] degrees F
Silica (SiO_2)	[_____] ppm (mg/1)
Insoluble	[_____] ppm (mg/1)
Iron and Aluminum Oxides	[_____] ppm (mg/1)
Calcium (Ca)	[_____] ppm (mg/1)
Magnesium (Mg)	[_____] ppm (mg/1)

Sodium and Potassium (Na and K)	[_____] ppm (mg/1)
Carbonate (HCO3)	[_____] ppm (mg/1)
Sulfate (SO4)	[_____] ppm (mg/1)
Chloride (C1)	[_____] ppm (mg/1)
Nitrate (NO3)	[_____] ppm (mg/1)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] epm (meq/1)
Noncarbonate Hardness	[_____] epm (meq/1)
Total Hardness	[_____] epm (meq/1)
Dissolved Solids	[_____] ppm (mg/1)
Fluorine	[_____] ppm (mg/1)
Conductivity	[_____] microhm, cm

2.15.2 Boiler Water Limits

****

NOTE: The material contained within the first set of brackets will be used for steam boilers. The material contained within the second set of brackets will be used for hot water boilers.

****

The boiler manufacturer shall be consulted for the determination of the boiler water chemical composition limits. The boiler water limits shall be as follows unless dictated differently by the boiler manufacturer's recommendations:

[Causticity	20-200 ppm
Total Alkalinity (CACO3)	900-1200 ppm
Phosphate	30-60 ppm
Tanin	Medium
Dissolved Solids	3000-5000 ppm
Suspended Solids	300 ppm Max
Sodium Sulfite	20-40 ppm Max
Silica	Less than 150 ppm
Dissolved Oxygen	Less than 7 ppm
Iron	10 ppm
pH (Condensate)	7 - 8]
[Sodium Sulfite	20-40 ppm
Hardness	Less than 2 ppm
pH	9.3 - 9.9]

2.15.3 Water Softening System

****

NOTE: The makeup water analysis and the boiler manufacturer's recommended feed water conditions will be used to determine the need for a water softener. TM 5-650 contains general guidance for the selection.

****

The water softening system shall be as specified in Section 11250 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE).

2.15.4 Chemical Feed Pumps

****
NOTE: The required maximum pump flow rate will be shown on the drawings. The flow rate will depend upon the makeup water flow rate and the chemical composition of the makeup water. A water treatment company should be consulted for determining the proper maximum pump flow rate.
****

One pump shall be provided for each chemical feed tank. The chemical feed pumps shall be positive displacement diaphragm type. The capacity of the pumps shall be adjustable from 0 to 100 percent while in operation. The discharge pressure of the pumps shall be not less than 1.5 times the pressure at the point of connection. The pumps shall be provided with a pressure relief valve and a check valve mounted in the pump discharge.

2.15.5 Tanks

****
NOTE: A water treatment company will be consulted to determine the number of tanks required. The number will depend on the size of the boiler, makeup water flow rate, and makeup water composition. A water line will be provided near the tanks for the mixing of chemicals.
****

The tanks shall be constructed of [high density polyethylene] [stainless steel] with a hinged cover. The tanks shall have sufficient capacity to require recharging only once per 7 days during normal operation. A level indicating device shall be included with each tank. An electric agitator shall be provided for each tank.

2.15.6 Injection Assemblies

An injection assembly shall be provided at each chemical injection point located along the boiler piping as indicated. The injection assemblies shall be constructed of stainless steel. The discharge of the assemblies shall extend to the centerline of the piping. Each assembly shall include a shutoff valve and check valve at the point of entrance into the water line.

2.15.7 Water Meter

The water meter shall be provided with an electric contacting register and remote accumulative counter. The meter shall be installed within the makeup water line, as indicated.

2.15.8 Water Treatment Control Panel

****
NOTE: The MAN-OFF-AUTO switch should be deleted for continuously fed systems.
****

The control panel shall be a NEMA 12, single door, wall-mounted box conforming with NEMA 250. The panel shall be constructed of [steel] [stainless steel] with a hinged door and lock. The panel shall contain, as a minimum, the following functions identified with a laminated plastic nameplate:

a. Main power switch and indicating light

b. MAN-OFF-AUTO selector switch

c. Indicating lamp for blow down

d. Indicating lamp for each chemical feed pump

e. Indicating lamp for the water softener

2.15.9 Sequence of Operation

****
NOTE: Manually set flow rates should only be used when fluctuations in steam demand and makeup water are not expected. Typically, automatic blowdown will be economical for boilers with capacities greater than 2.9 MW (10,000,000 Btuh).
****

The flow rate of chemical addition shall be based upon [metering the makeup water.] [a manual setting.] The boiler shall be provided with [continuous blowdown.] [automatic blowdown based upon conductivity or boiler load.] The required rate of chemical feed and boiler blowdown shall be determined by the water treatment company.

2.15.10 Chemical Shot Feeder

A shot feeder shall be provided as indicated. Size and capacity of feeder shall be based upon local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.15.11 Chemical Piping

****
NOTE: If steel piping is selected, an interior coating may be required depending upon the chemicals used.
****

The piping and fittings shall be constructed of [schedule 80 PVC] [steel] [stainless steel].

2.15.12 Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided.

PART 3 EXECUTION

3.1 ERECTION OF BOILER AND AUXILIARY EQUIPMENT

****

NOTE: Consult boiler manufacturers for foundation requirements. Delete the requirement for packing the joint between the boiler and floor with nonasbestos rope, if not required. This packing is typically not required for smaller units.

****

Boiler and auxiliary equipment shall be installed in accordance with manufacturer's written instructions. Proper provision shall be made for expansion and contraction between boiler foundation and floor. This joint shall be packed with suitable nonasbestos rope and filled with suitable compound that will not become soft at a temperature of 100 degrees F. Boilers and firing equipment shall be supported from the foundations by structural steel completely independent of all brickwork. Boiler supports shall permit free expansion and contraction of each portion of the boiler without placing undue stress on any part of the boiler or setting. Boiler breeching shall be as indicated with full provision for expansion and contraction between all interconnected components.

3.2 PIPING INSTALLATION

Unless otherwise specified, nonboiler external pipe and fittings shall conform to the requirements of ASME B31.1. Pipe installed shall be cut accurately to suit field conditions, shall be installed without springing or forcing, and shall properly clear windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Pipes shall be free of burrs, oil, grease and other foreign material and shall be installed to permit free expansion and contraction without damaging the building structure, pipe, pipe joints, or pipe supports. Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Vent pipes shall be carried through the roof as directed and shall be properly flashed. Unless otherwise indicated, horizontal supply mains shall pitch down in the direction of flow with a grade of not less than 1 inch in 40 feet. Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated. Unless otherwise specified or shown, final connections to equipment shall be made with malleable-iron unions for steel pipe 2-1/2 inches or less in diameter and with flanges for pipe 3 inches or more in diameter. Unions for copper pipe or tubing shall be brass or bronze. Reducing fittings shall be used for changes in pipe sizes. In horizontal hot water lines, reducing fittings shall be eccentric type to maintain the top of the lines at the same level to prevent air binding.

3.2.1 Hot Water Piping and Fittings

Pipe shall be black steel or copper tubing. Fittings for steel piping shall be black malleable iron or cast iron to suit piping. Fittings adjacent to valves shall suit valve material. Grooved mechanical fittings will not be allowed for water temperatures above 230 degrees F.

3.2.2 Vent Piping and Fittings

Vent piping shall be black steel. Fittings shall be black malleable iron or cast iron to suit piping.

3.2.3   Gauge Piping

Piping shall be copper tubing.

3.2.4   Steam Piping and Fittings

Piping shall be black steel. Fittings shall be black, malleable iron, cast iron or steel. Fittings adjacent to valves shall suit valves specified. Grooved mechanical fittings will not be allowed for steam piping.

3.2.5   Condensate Return Pipe and Fittings

Piping shall be black steel. Fittings shall be malleable iron, cast iron, or steel. Grooved mechanical fittings will not be allowed for condensate piping.

3.2.6   Joints

Joints between sections of steel pipe and between steel pipe and fittings shall be threaded, grooved, flanged or welded as indicated or specified. Except as otherwise specified, fittings 1 inch and smaller shall be threaded; fittings 1-1/4 inches and up to but not including 3 inches shall be either threaded, grooved, or welded; and fittings 3 inches and larger shall be either flanged, grooved, or welded. Pipe and fittings 1-1/4 inches and larger installed in inaccessible conduit or trenches beneath concrete floor slabs shall be welded. Connections to equipment shall be made with black malleable-iron unions for pipe 2-1/2 inches or smaller in diameter and with flanges for pipe 3 inchesinches or larger in diameter. Joints between sections of copper tubing or pipe shall be flared, soldered, or brazed.

3.2.6.1   Threaded Joints

Threaded joints shall be made with tapered threads properly cut and shall be made perfectly tight with a stiff mixture of graphite and oil or with polytetrafluoroethylene tape applied to the male threads only and in no case to the fittings.

3.2.6.2   Welded Joints

Welded joints shall be in accordance with paragraph GENERAL REQUIREMENTS unless otherwise specified. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, shall be forged, flared for improved flow characteristics where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength. Socket weld joints shall be assembled so that the space between the end of the pipe and the bottom of the socket is no less than 1/16 inch and no more than 1/8 inch.

3.2.6.3   Grooved Mechanical Joints

Grooved mechanical joints may be provided for hot water systems in lieu of unions, welded, flanged, or screwed piping connections in low temperature hot water systems where the temperature of the circulating medium does not exceed 230 degrees F. Grooves shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations. Mechanical joints shall use rigid mechanical pipe couplings, except at equipment connections. At equipment connections, flexible couplings may be used. Coupling shall be of the bolted type for use with grooved end pipes, fittings, valves, and strainers. Couplings shall be self-centering and shall engage in a watertight couple.

3.2.6.4 Flared and Brazed Copper Pipe and Tubing

Tubing shall be cut square, and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing shall not occur when making connections. Installation shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA Tube Handbook with flux. Copper-to-copper joints shall include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorous, copper-phosphorous-silver or a silver brazing filler metal. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided in all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Flared or brazed copper tubing to pipe adapters shall be provided where necessary for joining threaded pipe to copper tubing.

3.2.6.5 Soldered Joints

Soldered joints shall be made with flux and are only acceptable for lines 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA Tube Handbook.

3.2.6.6 Copper Tube Extracted Joint

An extruded mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

3.2.7 Flanges and Unions

Flanges shall be faced true, provided with 1/16 inch thick gaskets, and made square and tight. Where steel flanges mate with cast-iron flanged fittings, valves, or equipment, they shall be provided with flat faces and full face gaskets. Union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Dielectric pipe unions shall be provided between ferrous and nonferrous piping to prevent galvanic corrosion. The dielectric unions shall have metal connections on both ends. The ends shall be threaded, flanged, or brazed to match adjacent piping. The metal parts of the union shall be separated so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact. Gaskets, flanges, and unions shall be installed in accordance with manufacturer's recommendations.

3.2.8 Branch Connections

****
NOTE: Select the appropriate type of branch connections and delete those which are not required.
****

3.2.8.1 Branch Connections for Hot Water Systems

Branches from the main shall pitch up or down as shown to prevent air entrapment. Connections shall ensure unrestricted circulation, eliminate air pockets, and permit complete drainage of the system. Branches shall pitch with a grade of not less than 1 inch in 10 feet. When indicated, special flow fittings shall be installed on the mains to bypass portions of the water through each radiator. Special flow fittings shall be standard catalog products and shall be installed as recommended by the manufacturer.

3.2.8.2 Branch Connections for Steam Systems

Branches shall be taken from the supply mains at an angle of 45 degrees above the horizontal, unless otherwise indicated. The branches from return mains shall be taken from the top or sides, unless indicated otherwise. Branches shall pitch up from the mains toward the undripped risers or radiator connections with a grade of not less than 1 inch in 10 feet. Connections to ensure unrestricted circulation, eliminate air pockets, and permit the complete drainage of the system.

3.2.9 Steam Connections to Equipment

****
NOTE: Delete this paragraph if steam connections are not required.
****

Steam supply and return connections shall be provided as shown. Connections shall be made with malleable-iron unions or with steel flanges, to match equipment. Valves and traps shall be installed in accordance with the manufacturer's recommendations. The size of the supply and return pipes to each piece of equipment shall not be smaller than the outlets on the equipment.

3.2.10 Steam Risers

****
NOTE: Delete this paragraph if steam risers are not

required.
****

The location of risers is approximate. The exact locations of the risers shall be approved. Downfeed risers shall terminate in a dirt pocket and shall be dripped through a trap to the return line.

3.2.11 Air Vents for Steam Systems

****
NOTE: Delete this paragraph if a steam system is not utilized.
****

Automatic balanced pressure thermostatic air vents shall be installed at the ends of the steam lines and where shown on the drawings. The vents shall be rated for 125 psi steam service. The outlet of the vent shall be routed to a point designated by the Contracting Officer's Representative. The inlet line shall have a gate valve or ball valve.

3.2.12 Flared, Brazed, and Soldered Copper Pipe and Tubing

Copper tubing shall be flared, brazed, or soldered. Tubing shall be cut square, and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing shall not occur when making connections. Installation shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided on branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Pipe adapters shall be provided where necessary for joining threaded pipe to copper tubing. Brazed joints shall be made in conformance with MSS SP-73, and CDA Tube Handbook. Copper-to-copper joints shall include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorous, copper-phosphorous-silver, or a silver brazing filler metal. Soldered joints shall be made with flux and are only acceptable for lines 2 inches or smaller. Soldered joints shall conform to ASME B31.5 and shall be in accordance with CDA Tube Handbook.

3.2.13 Copper Tube Extracted Joint

An extracted mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

3.2.14 Supports

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load.

Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. Threaded rods which are used for support shall not be formed or bent.

3.2.14.1 Seismic Requirements for Supports and Structural Bracing

****
NOTE: Provide seismic requirements, if a Government designer (either Corps Office of A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if no seismic requirements are provided. Sections13080 and 15070, properly edited, must be included in the contract documents.
****

Piping and attached valves shall be supported and braced to resist seismic loads as specified in Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070SSEISMIC PROTECTION FOR MECHANICAL EQUIPMENT [as shown on the drawings]. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided in this section. Material used for supports shall be as specified in Section 05120 STRUCTURAL STEEL.

3.2.14.2 Pipe Hangers, Inserts, and Supports

****
NOTE: Details of pipe supports in trenches will be shown on the drawings. Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.
****

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe, if the clamp bottom does not extend through the insulation, and if the top clamp attachment does not contact the insulation during pipe movement.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices furnished by the manufacturer. Field fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves.

h. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet,not more than 8 feet from end of risers, and at vent terminations.

i. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

   (1) Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle may be welded to the pipe and freely rested on a steel plate. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rested on a steel slide plate.

   (2) Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide shall include a pipe cradle welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.

j. Except for Type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.

k. Piping in trenches shall be supported as indicated.

l. Structural steel attachments and brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material and installation shall be as specified under Section 05120 STRUCTURAL STEEL. Pipe hanger loads suspended from steel joist between panel points shall not exceed 50 pounds. Loads exceeding 50 pounds shall be suspended from panel points.

3.2.14.3 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support member shall not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run. The clips or clamps shall be rigidly attached to the common base member. A clearance of 1/8 inch shall be provided between the pipe insulation and the clip or clamp for piping which may be subjected to thermal expansion.

3.2.15 Anchors

****
NOTE: Anchors will be coordinated with seismic bracing. Seismic bracing should not interfere with the thermal expansion design.
****

Anchors shall be provided where necessary to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results, using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

3.2.16 Valves

Valves shall be installed where indicated, specified, and required for functioning and servicing of the systems. Valves shall be safely accessible. Swing check valves shall be installed upright in horizontal lines and in vertical lines only when flow is in the upward direction. Gate and globe valves shall be installed with stems horizontal or above. Valves to be brazed shall be disassembled prior to brazing and all packing removed. After brazing, the valves shall be allowed to cool before reassembling.

3.2.17 Pipe Sleeves

Pipe passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. A waterproofing clamping flange shall be installed as indicated where membranes are involved. Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof. Sleeves through walls shall be cut flush with wall surface. Sleeves through floors shall [be cut flush with floor surface] [extend above top surface of floor a sufficient distance to allow proper flashing or finishing]. Sleeves through roofs shall extend above the top surface of roof at least 6 inches for proper flashing or finishing. Unless otherwise indicated, sleeves shall be sized to provide a minimum clearance of 1/4 inch between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in waterproofing membrane floors, bearing walls, and wet areas shall be galvanized steel pipe or cast-iron pipe. Sleeves in nonbearing walls, floors, or ceilings may be galvanized steel pipe, cast-iron pipe, or galvanized sheet metal with lock-type longitudinal seam. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls shall be sealed as indicated and specified in Section 07900 JOINT SEALING. Metal jackets shall be provided over insulation passing through exterior walls, firewalls, fire partitions, floors, or roofs.

a. Metal jackets shall not be thinner than 0.006 inch thick aluminum, if corrugated, and 0.016 inch thick aluminum, if smooth.

b. Metal jackets shall be secured with aluminum or stainless steel bands not less than 3/8 inch wide and not more than 8 inches apart. When penetrating roofs and before fitting the metal jacket into place, a 1/2 inch wide strip of sealant shall be run vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum height of 36 inches above the roof. If the pipe turns from vertical to horizontal, the sealant strip shall be run to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, the metal jacket shall extend from a point below the back-up material to a minimum distance of 2 inches above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 12 inches above material to a minimum distance of 2 inches above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 12 inches above the floor; when passing through walls above grade, the jacket shall extend at least 4 inches beyond each side of the wall.

3.2.17.1 Pipes Passing Through Waterproofing Membranes

****

NOTE: Typical details of pipe sleeves through walls, floors, and roofs are shown in TM 5-805-6. The applicable detail plates will be completed and included in the contract drawings.

****

In addition to the pipe sleeves referred to above, pipes passing through waterproofing membranes shall be provided with a 4 pound lead flashing or a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall set over the membrane in a troweled coating of bituminous cement. The flashing shall extend above the roof or floor a minimum of 10 inches. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Pipes up to and including 10 inchesin diameter which pass through waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

3.2.17.2 Optional Modular Mechanical Sealing Assembly

At the option of the Contractor, a modular mechanical type sealing assembly may be installed in the annular space between the sleeve and conduit or pipe in lieu of a waterproofing clamping flange and caulking and sealing specified above. The seals shall include interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

3.2.17.3 Optional Counterflashing

As alternates to caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may consist of standard roof coupling for threaded pipe up to 6 inches in diameter, lead flashing sleeve for dry vents with the sleeve turned down into the pipe to form a waterproof joint, or a tack-welded or banded-metal rain shield around the pipe, sealed as indicated.

3.2.17.4 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, a fire seal shall be provided as specified in Section 07840 FIRESTOPPING.

3.2.18 Balancing Valves

Balancing valves shall be installed as indicated.

3.2.19 Thermometer Wells

A thermometer well shall be provided in each return line for each circuit in multicircuit systems.

3.2.20 Air Vents

Air vents shall be installed where shown or directed. Air vents shall be installed in piping at all system high points. The vent shall remain open until water rises in the tank or pipe to a predetermined level at which time it shall close tight. An overflow pipe from the vent shall be run to a point designated by the Contracting Officer's representative. The inlet to the air vent shall have a gate valve or ball valve.

3.2.21 Escutcheons

Escutcheons shall be provided at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrews.

3.2.22 Drains

A drain connection with a 1 inch gate valve or 3/4 inch hose bib shall be installed at the lowest point in the return main near the boiler. In addition, threaded drain connections with threaded cap or plug shall be installed on the heat exchanger coil on each unit heater or unit ventilator and wherever required for thorough draining of the system.

3.2.23 Strainer Blow-Down Piping

Strainer blow-down connections shall be fitted with a black steel blow-down pipeline routed to an accessible location and provided with a blow-down valve.

3.2.24 Direct Venting for Combustion Intake Air and Exhaust Air

****

NOTE: Delete this paragraph if condensing boilers are not used.
****

The intake air and exhaust vents shall be installed in accordance with NFPA 54 and boiler manufacturer's recommendations. The exhaust vent shall be sloped 1/4 inch per ft toward the boiler's flue gas condensate collection point.

3.3 GAS FUEL SYSTEM

Gas piping, fittings, valves, regulators, tests, cleaning, and adjustments shall be in accordance with the Section 15190 GAS PIPING SYSTEMS. NFPA 54 shall be complied with unless otherwise specified. Burners, pilots, and all accessories shall be listed in UL Gas&Oil Dir. The fuel system shall be provided with a gas tight, manually operated, UL listed stop valve at the gas-supply connections, a gas strainer, a pressure regulator, pressure gauges, a burner-control valve, a safety shutoff valve suitable for size of burner and sequence of operation, and other components required for safe, efficient, and reliable operation as specified. Approved permanent and ready facilities to permit periodic valve leakage tests on the safety shutoff valve or valves shall be provided.

3.4 FUEL OIL SYSTEM

Fuel oil system shall be installed in accordance with NFPA 31, unless otherwise indicated.

3.4.1 Piping and Storage Tank

Fuel oil piping and storage tanks shall be installed in accordance with Section 13202 FUEL STORAGE SYSTEMS, unless indicated otherwise.

3.4.2 Fuel-Oil Storage Tank Heating-Coil Piping

Supply and return piping and fittings for the heating coil shall be installed in accordance with paragraph PIPING INSTALLATION. The [hot water] [steam] supply line to the heating coil shall be provided with an automatic temperature-control valve, a strainer and a three-valve bypass. The return line from the coil shall be provided with a [check valve] [steam trap] and a block valve.

3.4.3 Automatic Safety Shutoff Valve

Oil supply line to each oil burner shall be equipped with an automatically operated valve designed to shut off the oil supply in case of fire in the immediate vicinity of the burner. The valve shall be thermoelectrically actuated or thermomechanically actuated type and shall be located immediately downstream of the manual shutoff valve at the day tank inside of the building. If a day tank is not used, the automatic safety valve shall be located immediately downstream of the building shutoff devices where oil supply line enters the building. A thermoelectrical or thermomechanical detection device shall be located over the oil burner to activate the valve. A fire shutoff valve may be combined with other automatic shutoff devices if listed in UL Gas&Oil Dir.

3.4.4 Earthwork

Excavation and backfilling for tanks and piping shall be as specified in

Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.5 RADIANT FLOOR HEATING SYSTEM

The radiant floor heating system shall be installed in accordance with HYI-400, unless otherwise indicated by the tubing manufacturer's installation instructions. During the installation, all tubing shall be plugged on each end to prevent foreign materials from entering the tubing. All tubing shall be checked for abrasions prior to installation. Tubing with excessive abrasions that damage the oxygen barrier coating will not be acceptable. Tubing with any abrasion that is greater than 10 percent of the minimum wall thickness will not be acceptable. All tubing embedded or concealed by the floor shall be installed without joints. The bending radius of the tubing shall not exceed the values recommended by the tubing manufacturer. The tubing shall be installed in such a manner as to evenly distribute the heat across the floor. Tubing shall not be placed near heat sensitive materials such as water closet seals. Isolation valves shall be installed on each side of each tubing manifold. The manifold and fittings shall be accessible for maintenance. After the system is filled with water or glycol, all air shall be vented from the system. After the system is allowed to stabilize at the operating temperatures of the heating fluid, the system shall be vented again.

3.5.1 Concrete Slab construction

****

NOTE: Delete this paragraph if slab construction is not required. The type of installation under the slab should be coordinated with the architect and structural engineer.

****

In areas where tubing must cross expansion joints, control joints, or other crack control measures, the tubing shall be installed below the joints. The tubing shall be fastened to the reinforcing steel in accordance with the tubing manufacturer's recommendations. The tubing shall be pressurized prior to and during the concrete pour to ensure system integrity.

3.5.2 Wooden Floor Construction

****

NOTE: Delete this paragraph if a wooden floor construction is not required.

****

Tubing shall be fastened to the wood subflooring in accordance with the drawings and the tubing manufacturer's recommendations. The method of attaching the tubing to the flooring shall not cause abrasions on the tubing.

3.5.3 Penetrations to Fire Rated Assemblies

Where pipe pass through firewalls, fire partitions, or floors, a fire seal shall be provided as specified in Section 07840 FIRESTOPPING.

3.6 FIELD PAINTING

****

NOTE: Where identification of piping is required by the using service, this paragraph will be amplified to include appropriate requirements either directly or by reference to a separate section. Air Force requirements are covered in AFM 88-15.
****

Ferrous metal not specified to be coated at the factory shall be cleaned, prepared, and painted as specified in Section 09900 PAINTING, GENERAL. Exposed pipe covering shall be painted as specified in Section 09900 PAINTING, GENERAL. Aluminum sheath over insulation shall not be painted.

3.7 TEST OF BACKFLOW PREVENTION ASSEMBLIES

Backflow prevention assemblies shall be tested in accordance with Section 15400, PLUMBING, GENERAL PURPOSE.

3.8 HEATING SYSTEM TESTS

****
NOTE: Whenever possible, the testing of heating systems will be done under adverse winter conditions and low outside temperatures. The test data included will be modified as required to suit the particular heating system.

Select a 4 hour hydrostatic test for radiant floor heating systems per HYI 400. All other systems should be tested for 2 hours.
****

Before any covering is installed on pipe or heating equipment, the entire heating system's piping, fittings, and terminal heating units shall be hydrostatically tested and proved tight at a pressure of 1-1/2 times the design working pressure, but not less than 100 psi. Before pressurizing system for test, items or equipment (e.g., vessels, pumps, instruments, controls, relief valves) rated for pressures below the test pressure shall be blanked off or replaced with spool pieces. Before balancing and final operating test, test blanks and spool pieces shall be removed; and protected instruments and equipment shall be reconnected. With equipment items protected, the system shall be pressurized to test pressure. Pressure shall be held for a period of time sufficient to inspect all welds, joints, and connections for leaks, but not less than 2 hours. No loss of pressure will be allowed. Leaks shall be repaired and repaired joints shall be retested. Repair joints shall not be allowed under the floor for floor radiant heating systems. If a leak occurs in tubing located under the floor in radiant heating systems, the entire zone that is leaking shall be replaced. If any repair is made above the floor for floor radiant heating systems, access shall be provided for the installed joint. Caulking of joints shall not be permitted. System shall be drained and after instruments and equipment are reconnected, the system shall be refilled with service medium and maximum operating pressure applied. The pressure shall be held while inspecting these joints and connections for leaks. The leaks shall be repaired and the repaired joints retested. Upon completion of hydrostatic tests and before acceptance of the installation, the Contractor shall balance the heating system in accordance with Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS; and operating tests required to demonstrate satisfactory functional and operational efficiency shall be performed. The operating test shall cover a period of at least 24 hours for each system, and shall include, as a minimum, the following specific information in a report, together with conclusions as to the adequacy of the system:

a. Certification of balancing.

b. Time, date, and duration of test.

c. Outside and inside dry bulb temperatures.

d. [Temperature of hot water supply leaving boiler] [Steam pressure].

e. Temperature of [heating return water from system at] [condensate feed to] boiler inlet.

f. Quantity of water feed to boiler.

g. Boiler make, type, serial number, design pressure, and rated capacity.

h. Fuel burner make, model, and rated capacity; ammeter and voltmeter readings for burner motor.

i. [Circulating] [Condensate] [Vacuum] pump make, model, and rated capacity, and ammeter and voltmeter readings for pump motor during operation.

j. Flue-gas temperature at boiler outlet.

k. Percent carbon dioxide in flue-gas.

l. Grade or type and calorific value of fuel.

m. Draft at boiler flue-gas exit.

n. Draft or pressure in furnace.

o. Quantity of water circulated.

p. Quantity of fuel consumed.

q. Stack emission pollutants concentration.

Indicating instruments shall be read at half-hour intervals unless otherwise directed. The Contractor shall furnish all instruments, equipment, and personnel required for the tests and balancing. Fuels, water, and electricity shall be obtained as specified in the SPECIAL CONTRACT REQUIREMENTS. The Contractor shall provide a minimum of [_____] gallons of grade No. [_____] fuel oil. Operating tests shall demonstrate that fuel burners and combustion and safety controls meet the requirements of [ASME CSD-1] [ANSI Z21.13] [NFPA 8501]

3.8.1 Water Treatment Testing

3.8.1.1 Water Quality Test

The boiler water shall be analyzed [prior to the acceptance of the facility] [a minimum of once a month for a period of 1 year] by the water treatment company. The analysis shall include the following information recorded in accordance with ASTM D 596.

Date of Sample	[_____]	
Temperature	[_____]	degrees F
Silica (SiO2)	[_____]	ppm (mg/1)
Insoluble	[_____]	ppm (mg/1)
Iron and Aluminum Oxides	[_____]	ppm (mg/1)
Calcium (Ca)	[_____]	ppm (mg/1)
Magnesium (Mg)	[_____]	ppm (mg/1)
Sodium and Potassium (Na and K)	[_____]	ppm (mg/1)
Carbonate (HCO3)	[_____]	ppm (mg/1)
Sulfate (SO4)	[_____]	ppm (mg/1)
Chloride (C1)	[_____]	ppm (mg/1)
Nitrate (NO3)	[_____]	ppm (mg/1)
Turbidity	[_____]	unit
pH	[_____]	
Residual Chlorine	[_____]	ppm (mg/1)
Total Alkalinity	[_____]	epm (meq/1)
Noncarbonate Hardness	[_____]	epm (meq/1)
Total Hardness	[_____]	epm (meq/1)
Dissolved Solids	[_____]	ppm (mg/1)
Fluorine	[_____]	ppm (mg/1)
Conductivity	[_____]	microhm/cm

If the boiler water is not in conformance with the boiler manufacturer's recommendations, the water treatment company shall take corrective action.

3.8.1.2 Boiler/Piping Test

****
NOTE: If a steam boiler is not used, delete the reference to condensate piping.
****

At the conclusion of the 1 year period, the boiler and condensate piping shall be inspected for problems due to corrosion and scale. If the boiler is found not to conform to the manufacturer's recommendations, and the water treatment company recommendations have been followed, the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations. If corrosion is found within the condensate piping, proper repairs shall be made by the water treatment company.

3.9 CLEANING

3.9.1 Boilers and Piping

After the hydrostatic tests have been made and before the system is balanced and operating tests are performed, the boilers and feed water piping shall be thoroughly cleaned by filling the system with a solution consisting of either 1 pound of caustic soda or 1 pound of trisodium phosphate per 50 gallons of water. The proper safety precautions shall be observed in the handling and use of these chemicals. The water shall be heated to approximately 150 degrees F and the solution circulated in the system for a period of 48 hours. The system shall then be drained and thoroughly flushed out with fresh water. Strainers and valves shall be thoroughly cleaned. Prior to operating tests, air shall be removed from all water systems by operating the air vents.

3.9.2   Heating Units

Inside space heating equipment, ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for fans that are operated during construction, and new filters shall be installed after construction dirt has been removed from the building, and the ducts, plenum, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.10   FUEL SYSTEM TESTS

3.10.1   Fuel Oil System Test

The fuel oil system shall be tested in accordance with Section 13202 FUEL STORAGE SYSTEMS.

3.10.2   Gas System Test

The gas fuel system shall be tested in accordance with the test procedures outlined in NFPA 54.

3.11   FIELD TRAINING

****

NOTE: The number of hours required for giving instructions for operation and maintenance will depend on the complexity of the system specified. The blank will be filled with the appropriate number. When the system is to be installed at a location where experienced Government engineers are on duty, delete the entire paragraph.

****

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of [_____] hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operation and maintenance instructions, as well as demonstrations of routine maintenance operations and boiler safety devices. The Contracting Officer shall be notified at least 14 days prior to date of proposed conduction of the training course.

-- End of Section --

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SECTION 15650

CENTRAL REFRIGERATED AIR-CONDITIONING SYSTEM
07/92

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NOTE: This guide specification covers the requirements for chilled water applications. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic

designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 450	(1993) Water-Cooled Refrigerant Condensers, Remote Type
ARI 460	(1994) Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ARI 480	(1995) Refrigerant-Cooled Liquid Coolers, Remote Type
ARI 495	(1993) Refrigerant Liquid Receivers
ARI 550	(1992) Centrifugal or Rotary Screw Water-Chilling Packages
ARI 560	(1992) Absorption Water Chilling and Water Heating Packages
ARI 575	(1994) Method of Measuring Machinery Sound Within an Equipment Space
ARI 590	(1992) Positive Displacement Compressor Water-Chilling Packages
ARI 700	(1995; Apx C) Specifications for Fluorocarbon and Other Refrigerants
ARI 710	(1995) Liquid-Line Driers
ARI 720	(1997) Refrigerant Access Valves and Hose Connectors
ARI 740	(1995) Refrigerant Recovery/Recycling Equipment
ARI 750	(1994) Thermostatic Refrigerant Expansion Valves
ARI 760	(1994) Solenoid Valves for Use with Volatile Refrigerants

AMERICAN BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA Std 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
AFBMA Std 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S1.13	(1995) Methods for the Measurement of Sound Pressure Levels

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990; R 1995) Ferritic Malleable Iron Castings
ASTM A 47M	(1990; R 1996) Ferritic Malleable Iron Castings (Metric)
ASTM A 48	(1994a) Gray Iron Castings
ASTM A 48M	(1994) Gray Iron Castings (Metric)
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 106	(1997a) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 181/A181M	(1995b) Carbon Steel Forgings for General-Purpose Piping
ASTM A 183	(1983; R 1990) Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	(1998) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 234/A 234M	(1997) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A 307	(1997) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 334/A 334M	(1996) Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B 32	(1996) Solder Metal
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1997) Seamless Copper Tube
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 88M	(1996) Seamless Copper Water Tube (Metric)

ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM B 280	(1997) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B 650	(1995) Electrodeposited Engineering Chromium Coatings on Ferrous Substrates
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM C 67	(1998a) Sampling and Testing Brick and Structural Clay Tile
ASTM C 534	(1994) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM D 520	(1984; R 1995) Zinc Dust Pigment
ASTM D 596	(1991; R 1995) Reporting Results of Analysis of Water
ASTM D 1384	(1997a) Corrosion Test for Engine Coolants in Glassware
ASTM D 1784	(1996) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2000	(1998c) Rubber Products in Automotive Applications
ASTM D 3308	(1997) PTFE Resin Skived Tape
ASTM E 84	(1998el) Surface Burning Characteristics of Building Materials
ASTM F 104	(1993) Nonmetallic Gasket Materials
ASTM F 1199	(1988, R 1998) Cast (All Temperature and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)
ASTM F 1200	(1988, R 1998) Fabricated (Welded) Pipe Line Strainers (Above 150 psig and 150 degrees F)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15	(1994) Safety Code for Mechanical Refrigeration
ASHRAE 34	(1992; Addenda a-j) Number Designation and Safety Classification of Refrigerants

ASHRAE 64	(1995) Methods of Testing Remote Mechanical-Draft Evaporative Refrigerant Condensers

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.5	(1996; B16..5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995; B16.22a) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(1986; R 1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.1	(1998) Power Piping
ASME B31.5	(1992; B31.5a) Refrigeration Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME PTC 23	(1986; Addenda 1992, R 1997) Atmospheric Water Cooling Equipment

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(1987) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding

AWS D1.1	(1998) Structural Welding Code - Steel

CALIFORNIA REDWOOD ASSOCIATION (CRA)

CRA RIS-01-SS	(1997) Standard Specifications for Grades of California Redwood Lumber

COOLING TOWER INSTITUTE (CTI)

CTI ATC-105	(1997) Acceptance Test Code
CTI Std-103	(1994) The Design of Cooling Towers with Redwood Lumber
CTI Std-111	(1998) Gear Speed Reducers
CTI Std-114	(1996) The Design of Cooling Towers with Douglas Fir Lumber
CTI Std-134	(1996) Plywood for Use in Cooling Towers
CTI Std-137	(1994) Fiberglass Pultruded Structural Products for Use in Cooling Towers
CTI WMS-112	(1986) Pressure Preservative Treatment of Lumber

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(1993; Addenda 1995; Errata 1996; 7th Ed. 1998) EJMA Standards

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.5	(1994) Centrifugal Pumps

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(1995) Butterfly Valves
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Gray Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-Welding Ends for General Service

MSS SP-78	(1998) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends
MSS SP-110	(1996) Ball Valves Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(1993) Industrial Controls and Systems
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3; Rev 4) Motors and Generators
NEMA SM 23	(1991) Steam Turbines for Mechanical Drive Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 37	(1998) Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 54	(1996; Errata) National Fuel Gas Code
NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems
NFPA 214	(1996) Water-Cooling Towers
NFPA 255	(1996) Method of Test of Surface Burning Characteristics of Building Materials

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J 537	(1996) Storage Batteries

UNDERWRITERS LABORATORIES (UL)

UL 1236	(1994; Rev thru Dec 1997) Battery Chargers for Charging Engine-Starter Batteries

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA Grading Rules	(1995; Supple Nos. 1 thru 5) Western

Lumber Grading Rules 95

1.2 SYSTEM DESCRIPTION

This specification section covers the provisions and installation procedures necessary for a complete and totally functional central refrigerated air-conditioning system as defined herein.

1.3 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Central Refrigerated Air-Conditioning System; [_____].

Manufacturer's catalog data, at least [5 weeks] [_____] prior to beginning construction, shall be highlighted to show model No., size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. Data shall be adequate to demonstrate compliance with contract requirements as specified within the paragraphs:

a. Refrigeration System
b. System Components
c. Accessories
d. Cooling Tower
e. Piping Components

If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

Water Treatment Systems; [_____].

[Six] [_____] complete copies, at least 5 weeks prior to the purchase of the water treatment system, of the proposed water treatment plan including a layout, control scheme, a list of existing make-up water conditions including the items listed in Paragraph Water Analysis, a list of chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

Spare Parts; [_____].

Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than [_____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with source of supply.

Qualifications; [_____].

[_____] copies of qualified procedures, and list of names and identification symbols of qualified welders and welding operators, prior to non-factory welding operations.

SD-04 Drawings

Central Refrigerated Air-Conditioning System ; [_____].

Drawings, at least [5 weeks] [_____] prior to beginning construction, shall provide adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

a. Equipment layouts which identify assembly and installation details.

b. Piping layouts which identify all valves and fittings.

c. Plans and elevations which identify clearances required for maintenance and operation.

d. Wiring diagrams which identify each component individually and all interconnected or interlocked relationships between components.

e. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations.

f. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

SD-06 Instructions

Posted Instructions; [_____].

Posted instructions, at least [2] [_____] weeks prior to construction completion, shall include equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

SD-07 Schedules

Factory Tests; [_____].

Schedules, at least [2] [_____] weeks prior to the factory test, which identify the date, time, and location for each test. Schedules shall be submitted for both the Chiller Performance Test and the Chiller Sound Test. [The Chiller Performance Test schedule shall also allow the witnessing of the test by a Government Representative.]

Tests; [_____].

Test schedules, at least [2] [_____] weeks prior to the start of related testing, for each of the field tests, the system performance tests, and the condenser water quality tests. The schedules shall identify the date, time, and location for each test.

Demonstrations; [_____].

A schedule, at least [2] [_____] weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

SD-08 Statements

Verification of Dimensions; [_____].

A letter, at least [2] [_____] weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found.

SD-09 Reports

Factory Tests; [_____].

[Six] [_____] copies of the report shall be provided in bound 8 1/2 x 11 inch booklets. Reports shall certify the compliance with performance requirements and follow the format of the required testing standard for both the Chiller Performance Tests and the Chiller Sound Tests. Test report shall include certified calibration report of all test instrumentation. Calibration report shall include certification that all test instrumentation has been calibrated within 6 months prior to the test date, identification of all instrumentation, and certification that all instrumentation complies with requirements of the test standard. Test report shall be submitted [1] [_____] week after completion of the factory test.

Field Tests; [_____].

[Six] [_____] copies of the report shall be provided in bound 8 1/2 x 11 inch booklets. Reports shall document all phases of tests performed during the Water Pipe Testing, the Refrigerant Pipe Testing, and the Cooling Tower Tests. The report shall include initial test summaries, all repairs/adjustments made, and the final test results.

System Performance Tests; [_____].

[Six] [_____] copies of the report shall be provided in bound 8 1/2 x 11 inch booklets. The report shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report shall also include the following information and shall be taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart:

a. Date and outside weather conditions.
b. The load on the system based on the following:

(1) The refrigerant used in the system.

(2) Condensing temperature and pressure.

(3) Suction temperature and pressure.

(4) For absorption units, the cooling water pressures and temperatures entering and exiting the absorber and condenser. Also the refrigerant solution pressures, concentrations, and temperatures at each measurable point within the system

(5) Running current, voltage and proper phase sequence for each phase of all motors.

(6) The actual on-site setting of all operating and safety controls.

(7) Chilled water pressure, flow and temperature in and out of the chiller.

(8) The position of the [capacity-reduction gear] [gas supply control valve] [fuel oil supply valve] at machine off, one-third loaded, one-half loaded, two-thirds loaded, and fully loaded.

Condenser Water Quality Tests; [_____].

Test reports, each month for a period of one year after project completion, in bound 8 1/2 x 11 inch booklets. The reports shall identifying the chemical composition of the condenser water. The reports shall also include a comparison of the manufacturer's recommended operating conditions for the cooling tower and condenser in relation to the condition of the condenser water. Any required corrective action shall be documented within the report.

Inspections; [_____].

[Six] [_____] copies of an inspection report, at the completion of one year of service, in bound 8 1/2 x 11 inch booklets. The report shall identifying the condition of each cooling tower and condenser. The report shall also include a comparison of the condition of the cooling tower and condenser with the manufacturer's recommended operating conditions. The report shall identify all actions taken by the Contractor and manufacturer to correct deficiencies during the first year of service.

SD-13 Certificates

Central Refrigerated Air-Conditioning System; [_____].

Where the system, components, or equipment are specified to comply with requirements of AGA, NFPA, ARI, ASHRAE, ASME, or UL, [1] [_____] copy of proof of such compliance shall be provided. The label or listing of the specified agency shall be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard ARI rating conditions, computer printouts, catalog, or other application data certified by ARI or a nationally recognized laboratory as described above shall be included. If ARI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

SD-19 Operation and Maintenance Manuals

Operation Manual; [_____].

[Six] [_____] complete copies of an operation manual in bound 8 1/2 x 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least [4] [_____] weeks prior to the first training course. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

Maintenance Manual; [_____].

[Six] [_____] complete copies of maintenance manual in bound 8 1/2 x 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

Water Treatment System; [_____].

[Six] [_____] complete copies of operating and maintenance manuals for the step-by-step water treatment procedures. The manuals shall include testing procedures used in determining water quality.

1.4 QUALIFICATIONS

****

NOTE: If the need exists for more stringent requirements for weldments, delete the first bracketed statement, otherwise delete the second.

****

[Piping shall be welded in accordance with the qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL.] [Welding and nondestructive testing procedures are specified in Section 05093 WELDING PRESSURE PIPING.]

1.5 SAFETY REQUIREMENTS

****

NOTE: Catwalk, ladder and guardrail may be required. If so, select the applicable item and delete the others and indicate on drawings the selected item. If not applicable, delete the entire sentence within the brackets.

****

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. [[Catwalk,] [ladder,] [and guardrail] shall be provided where indicated and in accordance with Section 05500 MISCELLANEOUS METAL.]

1.6 DELIVERY, STORAGE, AND HANDLING

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

1.7.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

PART 2 PRODUCTS

****

NOTE: Job specifications will be written to avoid restrictions on specific types of refrigerant (excluding CFC refrigerants) in order to encourage competitive bidding of available product offerings.

Minimum chiller efficiencies will either be presented in this specification or on the design drawings. Delete chiller efficiencies in the specification if efficiencies are shown on the drawings. If the efficiencies are shown on the drawings, reference the applicable ARI standard.

The following is a list of terms which are commonly used in regard to efficiency ratings of equipment defined within this specification.

COP - Coefficient of Performance (dimensionless)
EER - Energy Efficiency Ratio (Btuh/Watt)
IPLV - Integrated Part Load Value (dimensionless or kW/ton)
APLV - Application Part Load Value (dimensionless or kW/ton)

Note that the IPLV ratings presented by manufacturers are based upon standard rating conditions established by ARI. APLV ratings on the other hand are based upon site specific rating conditions. APLV ratings should be specified in most applications. APLV ratings will be coordinated with ARI and with the chiller manufacturers.

The following is a list of minimum full load and part load efficiency ratings to be used to specify electrically driven, air-cooled and water-cooled liquid chillers. Minimum efficiency ratings for absorption chillers are defined under paragraph ABSORPTION LIQUID CHILLER.

Minimum Efficiencies for Air-Cooled Chillers

	Full Load COP	Full Load (EER)	IPLV COP	IPLV (kW/ton)
Air-Cooled (with Condenser):				
527 kW (150 tons) or less =	2.8	(9.5)	3.1	(1.12)
greater than 527 kW (150 tons) =	2.7	(9.2)	2.9	(1.22)
Air-Cooled (Condenserless):				
All Capacities =	3.1	(10.6)	3.2	(1.10)

Minimum Efficiencies for Water-Cooled Chillers

Capacity	Full Load COP	Full Load (EER)	IPLV COP	IPLV (kW/ton)
281 kW (80 tons) or less =	3.9	(13.3)	4.7	(0.75)
greater than 281 kw (80 tons) or less than or equal to 351 kw (100 tons) =	3.9	(13.3)	5.1	(0.70)
greater than 351 kw (100 tons) or less than or equal to 702 kw (200 tons) =	4.7	(16.0)	5.4	(0.65)
greater than 702 kw (200 tons) or less than or equal to 1757 kw (500 tons) =	5.7	(19.4)	6.1	(0.58)

Minimum Efficiencies for Water-Cooled Chillers

Capacity	Full Load COP	Full Load (EER)	IPLV COP	IPLV (kW/ton)
greater than 1757 kW (500 tons) =	5.9	(20.0)	6.3	(0.56)

Because of typical manufacturing practices, air-cooled and small water-cooled chillers (typically less than 527 kW (150 tons)) are not available in multiple efficiencies for each available capacity. Only one model, and therefore, only one efficiency is available from a manufacturer for a given capacity. The minimum efficiencies stated above for air-cooled and small water-cooled chillers are low enough to allow all of the major chiller manufacturers to competitively bid. Specifying a higher efficiency for air-cooled and small water-cooled chillers will limit competition and may require a sole source justification.

Larger water-cooled chillers (greater than 527 kW (150 tons) are available in multiple efficiencies for each available capacity. The minimum efficiencies stated above are only guidelines in specifying efficiencies. The designer will be responsible for developing a life cycle cost comparison between available efficiencies to determine the optimum alternative. The decision to specify a more efficiency liquid chiller than the minimums defined above will typically be driven by the kW-hour costs, the electrical demand costs, and the chiller's annual energy usage. A designer should develop a sole source justification (if applicable) to procure the most life cycle cost effective chiller applicable. Coordinate chiller efficiencies with chiller manufacturers prior finalizing the specification.

The driving force in the procurement of higher efficient equipment is Executive Order 12902. Executive Order 12902 specifies that energy consuming products be selected which are in the top 25 percent of their class for energy efficiency or, at a minimum, at least 10 percent better than current federal minimum standards, to the extent practical and cost effective.

Full and part load efficiencies for gas-engine driven liquid chillers will have a COP of between 1.0 and 2.0 based upon operating conditions (i.e., with heat recovery, without heat recovery, etc.). A designer will coordinate with chiller manufacturers prior to specifying a minimum full or part load efficiency for a gas-engine driven chiller. Gas-engine driven chiller can be provided with compressors of the centrifugal type (typically larger than 2460 kW (700 tons)), the rotary screw type (intermediate sizes), the reciprocating type (typically up to 703 kW (200 tons)), and the scroll type (small system).

Projects which include vapor-compression type liquid chillers (this excludes absorption chillers) will comply with the safety standards defined in ASHRAE 15. Designers will be responsible for thoroughly researching and implementing the ASHRAE 15 safety requirements. For refrigerant-containing parts (excluding piping) located within an indoor space, a designer can use the following 6-step synopsis as a guide in determining "System Application Requirements" from ASHRAE 15.

Step 1. Identify the safety group classification of the refrigerant anticipated to be used in the new liquid chilling equipment. Refrigerants R-22 and R-134a are considered Group A1 refrigerants. Refrigerant R-123 is considered a Group B1 refrigerant.

Step 2. Identify the occupancy classification of the facility which will house the new liquid chilling equipment. Occupancies include institutional, public assembly, residential, commercial, large mercantile, industrial, and mixed types.

Step 3. Determine the system probability (high or low) of the new liquid chilling equipment. Liquid chillers are typically considered low-probability systems according to ASHRAE 15.

Step 4. Estimate the quantity of refrigerant (grams or pounds) in the largest single liquid chiller or largest refrigerant circuit of the new equipment. The designer will research catalog data from a minimum of 2 different liquid chiller manufacturers in order to get an approximation.

Step 5. Determine the volume (cubic meters or cubic feet) of the indoor space which is planned to house the new liquid chilling equipment.

Step 6. Identify the "System Application Requirements" from the applicable table in ASHRAE 15 based upon the information identified in the previous steps (e.g., safety group, occupancy, system probability, refrigerant quantity, and indoor

space volume). The "System Application Requirements" will dictate applicable refrigerant limitations as well as occupied space or mechanical room requirements. Typically, indoor spaces housing liquid chilling equipment must meet the mechanical room requirements defined in ASHRAE 15.

ASHRAE 15 refers to a mechanical room as a machinery room, however, the terms are synonymous. On mechanical room design, ASHRAE 15 touches on criteria concerning chiller placement, ventilation design, door and passageway restrictions, refrigerant monitoring, open-flame devices, pressure-relief and purge piping. In addition to mechanical room design, ASHRAE 15 also touches on criteria concerning refrigerant piping, signs, self-contained breathing apparatus (SCBA), and miscellaneous installation restrictions. (SCBAs cannot be considered MCA funded items and are therefore not included in this specification.)
****

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for two years prior to bid opening. The two-year use shall include applications of equipment and materials under similar circumstances and of similar size. The two years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a two-year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. All products shall be supported by a service organization. The Contractor shall submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and shall be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.2 NAMEPLATES

Each major component of equipment shall have the manufacturer's name, address, type or style, and catalog or serial number on a plate securely attached to the item of equipment. As a minimum, nameplates shall be provided for:

a. Liquid-Chilling Package(s)
b. Compressor(s)
c. Compressor Driver(s)
d. Condenser(s)
e. Liquid Cooler(s)
f. Receiver(s)

g. Pump(s)
h. Pump Motor(s)
i. Cooling Tower(s)
j. Cooling Tower Gear Drive Assemblies
k. Refrigerant Leak Detectors
l. Expansion Tanks
m. Air Separator Tanks

2.3 ELECTRICAL WORK

****
NOTE: Where motor starters for mechanical equipment are provided in motor-control centers, the references to motor starters shall be deleted.
****

Electrical equipment, motors, motor starters, and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics and enclosure type shall be as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, or totally enclosed fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor starter shall be provided in enclosures constructed in accordance with UL and [NEMA 1] [NEMA 3R] [NEMA [_____]] enclosures. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

2.4 SELF-CONTAINED LIQUID CHILLER

****
NOTE: Typically, units 500 tons or smaller are fully assembled and run-tested at the factory. Units larger than 500 tons are typically shipped and then assembled, charged, and run-tested in the field.
****

Unless necessary for delivery purposes, units shall be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the factory. In lieu of delivery constraints, a chiller may be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the job site by a factory representative. Unit components delivered separately shall be sealed and charged with a nitrogen holding charge. Unit assembly shall be completed in strict accordance with manufacturer's recommendations. Chiller shall operate within capacity range and speed recommended by the manufacturer. Parts weighing 50 pounds or more which must be removed for inspection, cleaning, or repair, such as motors, gear boxes, cylinder heads, casing tops, condenser, and cooler heads, shall have lifting eyes or lugs. Chiller shall be provided with factory installed insulation on surfaces subject to sweating including the liquid cooler, suction line piping, economizer, and cooling lines. Chiller shall include all customary auxiliaries deemed necessary by the manufacturer for safe, controlled, automatic operation of the equipment. Chiller shall be provided with a single point wiring connection for incoming power supply. Factory installed insulation shall be provided on all suction piping from the evaporator to the compressor and on the liquid cooler shell. Where motors are the gas-cooled type, factory installed insulation shall be provided on the cold-gas inlet connection to the motor per manufacturer's standard practice. Chiller's condenser and liquid cooler shall be provided with [standard] [marine] water boxes with [grooved mechanical] [flanged] [welded] connections.

2.4.1 Scroll, Reciprocating, or Rotary Screw Type

****

NOTE: These type units are typically available in capacities of 1406 kW (400 tons) or less.

****

Chiller shall be constructed and rated in accordance with ARI 590. Chiller shall be conform to ASHRAE 15. [Chiller shall have a minimum full load EER rating of [_____] and a part load kW/ton rating of [_____] in accordance with ARI 590.] As a minimum, chiller shall include the following components as defined in paragraph CHILLER COMPONENTS.

a. Refrigerant and oil
b. Structural base
c. Controls package
d. Scroll, reciprocating, or rotary screw compressor
e. Compressor driver, [electric motor] [gas-engine]
f. Compressor driver connection
g. Liquid cooler (evaporator)
f. [Air-] [Water-] condenser coil
g. [Heat recovery condenser]
h. [Receiver]
i. Tools
j. Chiller refrigerant circuit

2.4.2 Centrifugal or Rotary Screw Type

****

NOTE: These type units are typically available in capacities of 703 kW (150 tons) or more.

Rotary screw type units can be rated in accordance with either ARI 550 orARI 590. The primary difference between the two deals with the method of unloading. ARI 550 provides for continuous, non-stepped unloading from full load, down to minimum load. ARI 590, on the other hand, provides for stepped unloading in discrete increments between full load and part load (e.g., 100, 75, 50, 25, off) similar to reciprocating compressors. Typically, water-cooled rotary screw chillers larger than 200 tons are based upon ARI ANSI/ARI 550, while the smaller water-cooled and air-cooled models are based upon ARI 590.

****

Centrifugal chiller shall be constructed and rated in accordance with ARI 550. Rotary screw chiller shall be constructed and rated in accordance with ARI 550 or ARI 590 as applicable. [Chiller shall have a minimum full load EER rating of [_____] and a part load kW/ton rating of [_____] in accordance with ARI 550 or ARI 590 as applicable.] Chiller shall conform to ASHRAE 15. As a minimum, chiller shall include the following components as defined in paragraph CHILLER COMPONENTS.

a. Refrigerant and oil
b. Structural base
c. Controls package
d. Centrifugal or rotary screw compressor
e. Compressor driver, [electric motor] [gas-engine] [steam turbine]
f. Compressor driver connection
g. Liquid cooler (evaporator)
h. [Air-] [Water-] cooled condenser coil
i. [Heat recovery condenser coil]
i. [Receiver]
j. Purge system for chillers which operate below atmospheric pressure
k. Tools

2.5 SPLIT-SYSTEM LIQUID CHILLER

Total chiller system shall be constructed and rated in accordance with ARI 590. Individual chiller components shall be constructed and rated in accordance with the applicable ARI standards. Chiller system shall be conform to ASHRAE 15. [Chiller shall have a minimum full load EER rating of [_____] and a part load kW/ton rating of [_____] in accordance with ARI 590.] Chiller shall be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the job site by a factory representative. Unit components delivered separately shall be sealed and charged with a nitrogen holding charge. Unit assembly shall be completed in strict accordance with manufacturer's recommendations. Chiller shall operate within capacity range and speed recommended by the manufacturer. Parts weighing 50 pounds or more which must be removed for inspection, cleaning, or repair, shall have lifting eyes or lugs. Chiller components (excluding field installed refrigerant piping) shall be provided with factory installed insulation on surfaces subject to sweating. Chiller shall include all customary auxiliaries deemed necessary by the manufacturer for safe, controlled, automatic operation of the equipment. Chiller's condenser and liquid cooler shall be provided with [standard] [marine] water boxes with [grooved mechanical] [flanged] [welded] connections. As a minimum, chiller shall include the following components as defined in paragraph CHILLER COMPONENTS.

a. Refrigerant and oil
b. Structural base
c. Controls package
d. [Receiver]
e. Tools
f. Chiller refrigerant circuit

2.5.1 Compressor-Chiller

****

NOTE: For a complete system, a compressor-chiller must be specified along with a remote condenser.

****

As a minimum, the compressor-chiller unit shall include the following components as defined in paragraph CHILLER COMPONENTS.

a. Scroll, reciprocating, or rotary screw compressor
b. Compressor driver, electric motor
c. Compressor driver connection
d. Liquid cooler (evaporator)

2.5.2 Remote Air-Cooled Condenser

Condenser shall be a factory-fabricated and assembled unit, consisting of coils, fans, and electric-motor drive. Condenser shall be constructed and rated in accordance with ARI 460. Unless the condenser coil is completely protected through inherent design, louvered panel coil guards shall be provided by the manufacturer to prevent physical damage to the coil. Manufacturer shall certify that the condenser and associated equipment are designed for the submitted condensing temperature. For design conditions, if matched combination catalog ratings matching remote condensers to compressors are not available, the Contractor shall furnish a crossplotting of the gross heat rejection of the condenser against the gross heat rejection of the compressor, for the design conditions to show the compatibility of the equipment furnished.

2.5.2.1 Condenser Casing

Condenser casing shall be aluminum not less than 0.080 inch or hot-dip galvanized steel not lighter than 18 gauge. Condensers having horizontal air discharge shall be provided with discharge baffle to direct air upward, constructed of the same material and thickness as the casing.

2.5.2.2 Coil

****

NOTE: Standard coil construction is copper tubes with aluminum fins. For excessively corrosive atmospheres, either copper tubes with copper fins or aluminum tubes with aluminum fins should be considered. For additional corrosion protection, specify the manufacturer's standard epoxy or vinyl coating.

****

Condenser coil shall be of the extended-surface fin-and-tube type and shall be constructed of seamless [copper] [or] [aluminum] tubes with compatible [copper] [or] [aluminum] fins. Fins shall be soldered or mechanically bonded to the tubes and installed in a metal casing. Coils shall be circuited and sized for a minimum of 5 degrees F subcooling and full pumpdown capacity. Coil shall be factory leak and pressure tested after assembly in accordance with ASHRAE 15. [Coil shall be entirely coated with the manufacturer's standard epoxy or vinyl coating.]

2.5.2.3 Fans

****

NOTE: When the density of the ambient air to be handled by the fans differs substantially from the density of the standard air value of 1.2 kg per

cubic m (0.075 pound per cubic foot) at 21 degrees C (70 degrees F) and 101 kPa (29.92 inches mercury), the density of the air and/or the elevation above mean sea level will be stated.
****

Fans shall be centrifugal or propeller type as best suited for the application. Fans shall be direct or V-belt driven. Belt drives shall be completely enclosed within the unit casing or equipped with a guard. When belt drive is provided, an adjustable sheave to furnish not less than 20 percent fan-speed adjustment shall be provided. Sheaves shall be selected to provide the capacity indicated at the approximate midpoint of the adjustment. Fans shall be statically and dynamically balanced.

2.5.3 Remote Water-Cooled Condenser

Condenser shall be a factory-fabricated and assembled unit constructed and rated in accordance with ARI 450. Condenser shall be of the shell-and-coil or shell-and-tube type design. Condenser's refrigerant side shall be designed and factory pressure tested to comply with ASHRAE 15. Condenser's water side shall be designed and factory pressure tested for not less than [150 psi] [250 psi]. Condensers shall be complete with pressure relief valve or rupture disk, water drain connections, refrigerant charging valve, and stand or saddle. Low pressure refrigerant condenser shall be provided with a purge valve located at the highest point in the condenser to purge non-condensibles trapped in the condenser. Condenser shell shall be constructed of seamless or welded steel. Coil bundles shall be totally removable and arranged to drain completely. Tubes shall be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube shall be individually replaceable, except for the coaxial tubes. Tubes shall be installed into carbon mild steel tube sheets by rolling. Tube baffles shall be properly spaced to provide adequate tube support and cross flow.

2.5.3.1 Performance

Performance shall be based on water velocities not less than 3 fps nor more than 12 fps and a fouling factor of [0.00025] [0.0005].

2.5.3.2 Refrigerant Storage

Water-cooled condensers may be used for refrigerant storage in lieu of a separate liquid receiver, if the condenser storage capacity is 5 percent in excess of the fully charged system for single packaged systems and 20 percent in excess of the fully charged system for remote water cooled condensers.

2.5.4 Remote Evaporatively-Cooled Condenser

Condenser shall be rated and tested in accordance with requirements of ASHRAE 64. Condenser shall include fans, water pump with suction strainer, electric motor and drive equipment, water eliminators if required, condensing coil, liquid receiver if required, water pan or sump, spray nozzles or water-distribution pan, water strainer, water make-up assembly, bleeder with flow valve of the needle valve type sized for the flow required or a fixed orifice, enclosure with suitable access doors, and air-inlet and outlet openings. No water shall carry over into the unit discharge outlet.

2.5.4.1 Condenser Casing

Enclosure shall be constructed of not lighter than [18 gauge hot-dip galvanized steel] [0.080 inch aluminum], reinforced and braced. Access doors or panels suitably sized and located shall be provided for access to water nozzles or distribution pan, coils, and valves for cleaning, repair, or removal of the item. Access doors or panels shall be gasketed with synthetic rubber, or equivalent gasket material, and locked in place with thumb screws or catches. One-half inch mesh hot-dip galvanized steel or copper air-inlet screens shall be provided on each air inlet.

2.5.4.2 Refrigerant Section

Condenser coil shall be constructed of unfinned copper or steel tubes hot-dip galvanized after fabrication. The receiver shall be welded steel and shall be fitted and tested in accordance with ARI 495. A refrigerant charging valve shall be installed in the liquid line between the receiver cut-off valve and the expansion device. Refrigerant section shall be tested in accordance with ASHRAE 15 for the refrigerant employed in the system.

2.5.4.3 Fans

****

NOTE: When the density of the ambient air to be handled by the fans differs substantially from the density of the standard air value of 1.2 kg per cubic m (0.075 pound per cubic foot) at 21 degrees C (70 degrees F) and 101 kPa (29.92 inches mercury), the density of the air and/or the elevation above mean sea level will be stated.

****

Fans shall be centrifugal or propeller type as best suited for the application. Fans shall be direct or V-belt driven. Belt drives shall be completely enclosed within the unit casing or equipped with a guard. When belt drive is provided, an adjustable sheave to furnish not less than 20 percent fan-speed adjustment shall be provided. Sheaves shall be selected to provide the capacity indicated at the approximate midpoint of the adjustment. Fans shall be statically and dynamically balanced. Fan motor shall be totally enclosed type or open dripproof and located within an enclosure to be fully protected from the weather.

2.5.4.4 Water Section

Water eliminators shall be constructed of nonferrous metal, of an approved nonmetallic material, or of not lighter than 24 gauge steel, hot-dip galvanized after fabrication. Spray nozzles shall be brass nonclogging type designed to permit easy disassembly, and shall be arranged for easy access. Water pump shall be bronze-fitted centrifugal or turbine type, and may be mounted as an integral part of the evaporative condenser or remotely on a separate mounting pad. Pump suction shall be fully submerged and provided with screened inlet. Water pan or sump shall be constructed of not lighter than 14 gauge steel, hot-dip galvanized after fabrication, or molded acid-resistant glass-fiber-reinforced polyester. Water distribution pan shall be constructed of not lighter than 16 gauge steel, hot-dip galvanized after fabrication. Joints shall be watertight. Water pan or sump shall be provided with drain, overflow, and make-up water connection with stop valve and float valve. A bleed line with a flow valve of the needle type sized for the flow required or fixed orifice shall be provided in the pump discharge line and shall be extended to the nearest drain for continuous discharge.

2.5.5 Compressor Unit

****
NOTE: For a complete system, a compressor unit must be specified along with a remote condenser and a remote liquid cooler.
****

As a minimum, the condensing unit shall include the following components as defined in paragraph CHILLER COMPONENTS.

a. Scroll, reciprocating, or rotary screw compressor
b. Compressor driver, electric motor
c. Compressor driver connection

2.5.6 Remote Liquid Cooler (Evaporator)

Condenser shall be constructed and rated in accordance with ARI 480. Cooler shall be of the shell-and-coil or shell-and-tube type design. Condenser's refrigerant side shall be designed and factory pressure tested to comply with ASHRAE 15. Condenser's water side shall be designed and factory pressure tested for not less than [150 psi] [250 psi]. Cooler shell shall be constructed of seamless or welded steel. Coil bundles shall be totally removable and arranged to drain completely. Tubes shall be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube shall be individually replaceable. Tubes shall be installed into carbon mild steel tube sheets by rolling. Tube baffles shall be properly spaced to provide adequate tube support and cross flow. Cooler shall be skid-mounted. Refrigerant circuit shall be complete with liquid solenoid valve and expansion device capable of modulating to the minimum step of capacity unloading.

2.6 CHILLER COMPONENTS

****
NOTE: Coordinate the type of chiller components required with the type of chiller specified in the previous paragraphs. Components define under this paragraph do not apply to absorption type chillers. Delete this paragraph if only absorption type chillers are specified.
****

2.6.1 Refrigerant and Oil

****
NOTE: Non-absorption type chillers shall operate on a refrigerant with an ozone depletion potential (ODP) less than or equal to 0.05. R-22, R-123 and R-134a all meet this requirement.
****

Refrigerants shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ASHRAE 34. Refrigerants shall meet the requirements of ARI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.05.

2.6.2   Structural Base

Chiller and individual chiller components shall be provided with a factory-mounted welded structural steel base or support legs. Chiller and individual chiller components shall be isolated from the building structure by means of [molded neoprene isolation pads.] [vibration isolators with published load ratings. Vibration isolators shall have isolation characteristics as recommended by the manufacturer for the unit supplied and the service intended.]

2.6.3   Chiller Refrigerant Circuit

Chiller refrigerant circuit shall be completely piped and factory leak tested. For multicompressor units, not less than 2 independent refrigerant circuits shall be provided. Circuit shall include as a minimum a combination filter and drier, combination sight glass and moisture indicator, liquid-line solenoid valve for reciprocating or scroll units, an electronic or thermostatic expansion valve with external equalizer, charging ports, compressor service valves, and superheat adjustment.

2.6.4   Controls Package

Chiller shall be provided with a complete factory mounted and prewired electric or microprocessor based control system. Controls package shall be [unit-mounted] [floor-mounted where indicated] which contains as a minimum a digital display or acceptable gauges, an on-auto-off switch, motor starters, power wiring, control wiring, and disconnect switches. Controls package shall provide operating controls, monitoring capabilities, programmable setpoints, safety controls, and EMCS interfaces as defined below.

2.6.4.1   Operating Controls

****

NOTE: For proper startup and head pressure controls, enter the winter design temperature that the equipment will be subjected. Coordinate this temperature with manufacturers to assure available equipment.

A cooling tower bypass line and modulating control valve should be evaluated and incorporated into a design which requires chiller operation in ambient temperatures less than 13 degrees C (55 degree F).

****

Chiller shall be provided with the following adjustable operating controls as a minimum.

a. Leaving chilled water temperature control

b. Adjustable timer to prevent compressor from short cycling

c. Automatic lead/lag controls (adjustable) for multiprocessor units

d. Load limiting

e. [Fan sequencing for air-cooled condenser]

f. System capacity control to adjust the unit capacity in accordance with the system load and the programmable setpoints. Controls shall automatically re-cycle the chiller on power interruption.

g. Startup and head pressure controls to allow system operation at all ambient temperatures down to [_____] degrees [] [F]

2.6.4.2 Monitoring Capabilities

During normal operations, the control system shall be capable of monitoring and displaying the following operating parameters. Access and operation of display shall not require opening or removing any panels or doors.

a. Entering and leaving chilled water temperatures
b. Self diagnostic
c. Operation status
d. Operating hours
e. Number of starts
f. Compressor status (on or off)
g. Refrigerant discharge and suction pressures
h. [Condenser water entering and leaving temperatures]
i. [Number of purge cycles over the last 7 days]

2.6.4.3 Programmable Setpoints

The control system shall be capable of being reprogrammed directly at the unit. No parameters shall be capable of being changed without first entering a security access code. The programmable setpoints shall include the following as a minimum.

a. Leaving Chilled Water Temperature
b. [Leaving Condenser Water Temperature]
c. Time Clock/Calender Date

2.6.4.4 Safety Controls with Manual Reset

Chiller shall be provided with the following safety controls which automatically shutdown the chiller and which require manual reset.

a. Low chilled water temperature protection
b. High condenser refrigerant discharge pressure protection
c. Low suction pressure protection
d. Chilled water flow detection
e. Motor current overload and phase loss protection
f. High motor winding temperature protection for hermetic motors
g. Low oil flow protection

2.6.4.5 Safety Controls with Automatic Reset

Chiller shall be provided with the following safety controls which automatically shutdown the chiller and which provide automatic reset.

a. Over/under voltage protection
b. Phase reversal protection
c. Chilled water flow interlock

2.6.4.6 Remote Alarm

During the initiation of a safety shutdown, the control system shall be capable of activating a remote alarm bell. In coordination with the chiller, the contractor shall provide an alarm circuit (including transformer if applicable) and a minimum 4 inch diameter alarm bell. Alarm circuit shall activate bell in the event of machine shutdown due to the chiller's monitoring of safety controls. The alarm bell shall not sound for a chiller that uses low-pressure cutout as an operating control.

2.6.4.7 Energy Management Control System (EMCS) Interface

The control system shall be capable of communicating all data to a remote integrated DDC processor through a single shielded cable. The data shall include as a minimum all system operating conditions, capacity controls, and safety shutdown conditions. The control system shall also be capable of receiving at a minimum the following operating commands.

a. Remote Unit Start/Stop
b. Remote Chilled Water Reset
c. Remote Condenser Water Reset

2.6.5 Compressor(s)

2.6.5.1 Reciprocating Compressor(s)

All rotating parts shall be statically and dynamically balanced at the factory to minimize vibration. Compressors shall be capable of operating at partial-load conditions without increased vibration over the normal vibration at full load operation and shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors of size 10 horsepower and above shall have an oil lubrication system of the reversible, forced-feed type with oil strainer. Shaft seal in open-type units shall be mechanical type. Piston speed for open-type compressors shall not exceed the manufacturer's recommendation or 1200 fpm, whichever is less. Compressors shall include:

a. Vertical, V, W, or radial cylinder design

b. Oil lubrication

c. Integrally cast block of close-grained iron or cast aluminum block with hardened steel cylinder sleeves

d. Oil-level bull's eye

e. Cast cylinder heads

f. Cast-aluminum or forged-steel connecting rods

g. Cast iron or forged-steel crankshaft

h. Main bearings of the sleeve-insert type

i. Crankcase oil heaters controlled as recommended by the manufacturer

j. Suction and discharge refrigerant service valves that are flange connected, wrench operated, with cap

k. A strainer on the suction side of the compressor

l. [A hot-gas muffler to reduce vibration and noise from pulsations]

2.6.5.2 Scroll Compressor(s)

Compressors shall be of the compliant, hermetically sealed design. Compressors shall be mounted on vibration isolators to minimize vibration and noise. Rotating parts shall be statically and dynamically balanced at the factory to minimize vibration. Lubrication system shall be centrifugal pump type equipped with a means for determining oil level and an oil charging valve. Crankcase oil heater shall be provided if standard or if available as an option. If provided, the crankcase oil heater shall be controlled as recommended by the manufacturer.

2.6.5.3 Rotary Screw Compressor(s)

Compressors shall operate stably for indefinite time periods at any stage of capacity reduction without hot-gas bypass. Provision shall be made to insure proper lubrication of bearings and shaft seals on shutdown with or without electric power supply. Rotary screw compressors shall include:

a. An open or hermetic, positive displacement, oil-injected design directly driven by the compressor driver. Compressor shall allow access to internal compressor components for repairs, inspection, and replacement of parts.

b. Rotors which are solid steel forging with sufficient rigidity for proper operation.

c. A maximum rotor operating speed no greater than 3600 RPM.

d. Casings of cast iron, precision machined for minimal clearance about periphery of rotors.

e. A lubrication system of the forced-feed type that provides oil at the proper pressure to all parts requiring lubrication.

f. Shaft main bearings of the sleeve type with heavy duty bushings or rolling element type in accordance with AFBMA Std 9 or AFBMA Std 11. Bearings shall be conservatively loaded and rated for an L(10) life of not less than 200,000 hours.

g. A differential oil pressure or flow cutout to allow the compressor to operate only when the required oil pressure or flow is provided to the bearings.

h. A temperature- or pressure-initiated, hydraulically actuated, single-slide-valve, capacity-control system to provide minimum automatic capacity modulation from 100 percent to 25 percent.

i. An oil separator and oil return system to remove oil entrained in the refrigerant gas and automatically return the oil to the compressor.

j. Crankcase oil heaters controlled as recommended by the manufacturer.

2.6.5.4 Centrifugal Compressor(s)

****
NOTE: When centrifugal chillers are used for heat recovery duty, the entering heat recovery condenser water temperature is usually controlled to between 35 and 40 degrees C (95 and 105 degrees F) so that the water temperature leaving the heat recovery condenser is high enough to be used as a heat source. Under these conditions, the chiller will be operating at a higher head pressure than normally encountered. At these high head conditions, the centrifugal compressor may surge at part-load conditions of as high as 30 percent to 40 percent depending upon the conditions to which the chiller is subjected. In these cases, the designer should survey the manufacturers to determine at what load the available chillers will surge, at the conditions and loads to be encountered at the site. The bracketed sentences will be removed from the centrifugal chiller paragraph and replaced with the appropriate capacity control requirements. The designer should also consider multiple chillers to satisfy the load and to partition the loading to the chillers such that the heat recovery chiller load is sufficiently high to avoid surge. When examining heat recovery, full consideration should be given to the effect of 35-40 degrees C (95-105 degree F) water and the resulting power requirements of the chiller on the economic benefit of heat recovery.
****

Centrifugal compressors shall be single or multistage, having dynamically balanced impellers, either direct or gear driven by the compressor driver. Impellers shall be over-speed tested at 1.2 times the impeller-shaft speed. Impeller shaft shall be heat-treated alloy steel with sufficient rigidity for proper operation at any required operating speed. Centrifugal compressors shall include:

a. Shaft main bearings that are the rolling element type in accordance with AFBMA Std 9 or AFBMA Std 11, journal type with bronze or babbitt liners, or of the aluminum-alloy one-piece insert type. Bearings shall be rated for an L(10) life of not less than 200,000 hours.

b. Casing of cast iron, aluminum, or steel plate with split sections gasketed and bolted or clamped together.

c. Lubrication system of the forced-feed type that provides oil at the proper pressure to all parts requiring lubrication.

d. Provisions to ensure proper lubrication of bearings and shaft seals prior to starting and upon stopping with or without electric power supply. On units providing forced-feed lubrication prior to starting, a differential oil pressure cutout interlocked with the compressor starting equipment shall allow the compressor to operate only when the required oil pressure is provided to the bearings.

e. Oil sump heaters controlled as recommended by the manufacturer.

f. Temperature-or pressure-actuated prerotation vane or suction damper to provide automatic capacity modulation from 100 percent capacity to 10 percent capacity. If operation to 10 percent capacity cannot be achieved without providing hot-gas bypass, then the Contractor shall indicate in the equipment submittal the load percent at which hot gas bypass is required.

2.6.6 Compressor Driver, Electric Motor

Motor shall be the polyphase, induction type conforming to NEMA MG 1. Motors shall be suitable for use with the indicated electrical power characteristics and the type of starter provided. Motor starters shall be the reduced voltage, closed-transition type conforming to NEMA ICS 1 and NEMA ICS 2. Motor starter shall be [unit mounted] [remote mounted] as indicated with starter type, wiring, and accessories coordinated by the chiller manufacturer. Starter shall be able to operate in temperatures up to 120 degrees F.

2.6.7 Compressor Driver, Gas-Engine

****

NOTE: Natural gas-engine drives are used in conjunction with either reciprocating, rotary, or centrifugal type compressors.

The decision to use a heavy duty industrial type engine as compared to a standard automotive type engine will be based strictly on an economic comparison. The standard automotive type engines have a much lower initial cost, but they must be replaced and/or overhauled much more often. Also note that typically, standard automotive type engines are only available for chillers with a capacity of 500 tons or less.

****

Gas-engine compressor driver shall operate on natural gas and be in accordance with NFPA 37 and NFPA 54. Engine shall be designed for stationary applications and include all ancillaries necessary for operation. Engine shall be a manufacturer's standard production model and be specifically designed for chiller operation. Engine shall include as a minimum a [heavy duty industrial] [standard automotive] grade block, starting system, lubrication system, coolant system, engine heat exchanger, [engine cooling radiator,] fuel supply system, and controls package. Engine shall be naturally aspired, supercharged, or turbocharged and include appropriate air filters. Engine shall be 2- or 4-stroke-cycle and compression-ignition type. Engine shall be vertical in-line, V- or opposed-piston type, with a solid cast block or individually cast cylinders. Engine shall have a minimum of 2 cylinders. Opposed-piston type engines shall have not less than 4 cylinders. Engine block shall have a coolant drain port.

2.6.7.1   Starting System

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NOTE: Specify either an electric or pneumatic type starting system. Electric type system will be used for most applications. For installations where a compressed air system exists or is to be installed, a pneumatic starting system should be considered.
****

Engine starting system shall be the [electric] [pneumatic] type and be of sufficient capacity, at the maximum temperature specified, to crank the engine without damage or overheating. [Electric starting system shall operate on a [24] [_____]-volt DC system utilizing a negative circuit ground. A starting battery system shall be provided and shall include the battery, corrosion resistant battery rack, intercell connectors, spacers, automatic engine driven battery charger with overcurrent protection, metering and relaying. Battery shall be in accordance with SAE J 537. Battery charger shall conforming to UL 1236 and be the current-limiting type with overcurrent protection.] [Pneumatic starting system shall be as specified in Section 15400 PLUMBING, GENERAL PURPOSE, for a working pressure of [150 psi]].

2.6.7.2   Lubrication System

Engine shall be provided with a pressurized oil lubrication system. System shall include a lubrication oil pump that is engine driven. One full-flow filter shall be provided for each pump. Filters shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. System pressure shall be regulated as recommended by the engine manufacturer. A pressure relief valve shall be provided on the crankcase. Crankcase breathers shall be piped to the outside. System shall be readily accessible for servicing such as draining, refilling, and overhauling.

2.6.7.3   Coolant System

Engine shall include an automatic engine jacket water cooling system. Water shall be circulated through the system with an engine-driven circulating pump. [System coolant shall use a combination water and ethylene-glycol sufficient for freeze protection at the minimum temperature specified.]

2.6.7.4   Engine Heat Exchanger

Engine heat exchanger shall be of the shell-and-tube type construction and be in accordance with ASME BPV VIII Div 1. Shell material shall be carbon steel. Tubes shall be seamless copper or copper-nickel. Tubes shall be individually replaceable. Unit's waterside working pressure shall be rated for not less than 150 psig and factory tested at 150 percent of design working pressure. Water connections larger than 3 inches shall be ASME Class 1500 flanged. Unit shall be provided with gasketed removable covers, drains, and vents.

2.6.7.5   Engine Cooling Radiator

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NOTE: An engine cooling radiator will be needed to

satisfy an engine's cooling requirements if cooling tower water or heat recovery is not used.
****

Heat exchanger may be factory coated with corrosive resistant film, provided that correction measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via over sizing, or other compensating methods. Internal surfaces shall be compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Heat exchangers shall be the pressure type incorporating a pressure valve, vacuum valve and a cap. Caps shall be designed for pressure relief prior to removal. Each heat exchanger and the entire cooling system shall be capable of withstanding a minimum pressure of 7 psi and shall be protected with a strong grille or screen guard. Each heat exchanger shall have at least 2 tapped holes; one shall be equipped with a drain cock, the rest shall be plugged.

2.6.7.6 Fuel Supply System

Engine fuel supply system shall be factory mounted. System shall include a solenoid shut-off valve, a gas pressure regulator, carburetors or fuel injectors, and a throttle body assembly.

2.6.7.7 Controls Package

The controls for the gas-engine shall be incorporated into the overall controls package for the liquid chiller. The engine controls shall be capable of monitoring, displaying, and controlling the following conditions.

a. Coolant-fluid inlet and outlet temperatures
b. Lubricating-oil inlet and outlet temperatures and pressures
c. Engine run-time hours
d. Engine current status mode (on/off)
e. Engine speed
f. Percent engine load
g. Engine jacket temperature

2.6.7.8 Exhaust Piping

Horizontal sections of exhaust piping shall be sloped downward away from the engine to a drip leg for collection of condensate with drain valve and cap. Changes in direction shall be long radius. Exhaust piping and mufflers shall be insulated in accordance with Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Vertical exhaust piping shall be provided with a hinged, gravity-operated, self-closing, rain cover.

2.6.7.9 Exhaust Muffler

Engine shall be provided with a chamber type exhaust muffler. The muffler shall be of welded steel and designed for [outside] [inside] [vertical] [horizontal] mounting. Eyebolts, lugs, flanges, or other items shall be provided as necessary for support in the location and position indicated. Pressure drop through the muffler shall not exceed the recommendations of the engine manufacturer. Outside mufflers shall be zinc coated or painted with high temperature [_____] degrees resisting paint. The muffler and exhaust piping together shall reduce the noise level to less than [_____] dBa at a distance of 75 feet from the end of the exhaust piping with the chiller operating at 100 percent of rated output capacity. The muffler shall have a drain valve, nipple, and cap at the low-point of the muffler.

2.6.7.10   Exhaust System Connections

Flexible connectors shall be provided at the exhaust piping connection to the engine. An expansion joint shall be provided in the exhaust piping at the muffler connection. Flexible connectors and expansion joints shall have flanged connections. Flexible sections shall be made of convoluted seamless tube without joints or packing. Expansion joints shall be the bellows type. Expansion and flexible elements shall be stainless steel suitable for engine exhaust gas at 1000 degrees F. Flexible connectors and expansion joints shall be capable of absorbing vibration from the engine and compensation for thermal expansion and contraction.

2.6.8   Compressor Driver, Steam Turbine

Steam turbine shall conform to NEMA SM 23 and be suitable for direct connection to the compressor. Turbine shall have a capacity 10 percent greater than the compressor brake horsepower requirement at full-load condition. Steam strainer shall be either internally mounted or installed in connecting piping. Turbine shall include sentinel warning valve, forced-feed lubrication, oil cooler, oil reservoir, oil relief valve, oil piping, oil-pressure gauge, tachometer, and gland-seal piping if a condensing turbine is used. If a non-condensing turbine is used, provision shall be made for drain piping. The turbine shall be suitable for automatic control. An overspeed trip governor shall be provided to shut off the steam supply at 115 percent of design speed. Provision shall be made to stop the turbine upon operation of the compressor safety devices and upon power failure by the use of a solenoid trip on the emergency overspeed governor. Turbine shall be governed by a pneumatically controlled hydraulic governor during automatic operation and with a manual control effective during failure of the air supply. Pneumatic valve shall be actuated by a temperature controller with its sensing element in contact with the chilled water. Turbine shall be designed to operate at the steam pressure and exhaust conditions indicated. If the turbine is a condensing type, a surface-type steam condenser complete with single-stage air ejector, inter- and after-condenser, electric-driven dual condensate pumps, atmospheric relief valve, and expansion joint shall be furnished.

2.6.9   Compressor Driver Connections

****

NOTE: Delete the first set of brackets if a large liquid-chilling package is specified. Delete the second set of brackets if a condensing and compressing unit or a small liquid-chilling package is used.

****

[Each compressor shall be driven by a V-belt drive or direct connected through a flexible coupling, except that flexible coupling is not required on hermetic units. V-belt drives shall be designed for not less than 150 percent of the driving motor capacity. Flexible couplings shall be of the type that does not require lubrication.] [Each machine driven through speed-increasing gears shall be so designed as to assure self-alignment, interchangeable parts, proper lubrication, and minimum of unbalanced forces. Bearings shall be of the sleeve or roller type. Pressure lubrication with pump and cooler shall be provided. Gear cases shall be oil tight. Shaft extensions shall be provided with seals to retain oil and exclude all dust.]

2.6.10 Liquid Cooler (Evaporator)

Cooler shall be of the shell-and-coil or shell-and-tube type design. Condenser's refrigerant side shall be designed and factory pressure tested to comply with ASHRAE 15. Condenser's water side shall be designed and factory pressure tested for not less than [150 psi] [250 psi]. Cooler shell shall be constructed of seamless or welded steel. Coil bundles shall be totally removable and arranged to drain completely. Tubes shall be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube shall be individually replaceable. Tubes shall be installed into carbon mild steel tube sheets by rolling. Tube baffles shall be properly spaced to provide adequate tube support and cross flow. Performance shall be based on a water velocity not less than 3 fps nor more than 12 fps and a fouling factor of [0.00025] [0.0005].

2.6.11 Air-Cooled Condenser Coil

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NOTE: Standard coil construction is copper tubes with aluminum fins. For excessively corrosive atmospheres, either copper tubes with copper fins or aluminum tubes with aluminum fins should be considered. For additional corrosion protection, specify the manufacturer's standard epoxy or vinyl coating.

****

Condenser coil shall be of the extended-surface fin-and-tube type and shall be constructed of seamless [copper] [or] [aluminum] tubes with compatible [copper] [or] [aluminum] fins. Fins shall be soldered or mechanically bonded to the tubes and installed in a metal casing. Coils shall be circuited and sized for a minimum of 5 degrees F subcooling and full pumpdown capacity. Coil shall be factory leak and pressure tested after assembly in accordance with ASHRAE 15. [Coil shall be entirely coated with the manufacturer's standard epoxy or vinyl coating.]

2.6.12 Water-Cooled Condenser Coil

Condenser shall be of the shell-and-coil or shell-and-tube type design. Condenser's refrigerant side shall be designed and factory pressure tested to comply with ASHRAE 15. Condenser's water side shall be designed and factory pressure tested for not less than [150 psi] [250 psi]. Condensers shall be complete with pressure relief valve or rupture disk, water drain connections, and refrigerant charging valve. Low pressure refrigerant condenser shall be provided with a purge valve located at the highest point in the condenser to purge non-condensibles trapped in the condenser. Condenser shell shall be constructed of seamless or welded steel. Coil bundles shall be totally removable and arranged to drain completely. Tubes shall be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube shall be individually replaceable, except for the coaxial tubes. Tube baffles shall be properly spaced to provide adequate tube support and cross flow. Performance shall be based on water velocities not less than 3 fps nor more than 12 fps and a fouling factor of [0.00025] [0.0005].

2.6.13 Heat Recovery Condenser Coil

****

NOTE: The designer will conduct feasibility studies to determine if a heat recovery condenser is an economical addition to the system. Heat recovery condensers generally come in two sizes. The smaller of the two is generally sized to reject the superheat to the domestic water. The larger is sized to reject the same amount of heat as the standard condenser. The drawings will indicate the heat rejection capacity of the heat recovery condenser and the temperatures of the water to which it must reject the heat.

****

Condenser shall be of the shell-and-coil or shell-and-tube type design and shall not be a part of the standard condenser. Condenser shall be provided and installed by the chiller manufacturer. Condenser's refrigerant side shall be designed and factory pressure tested to comply with ASHRAE 15. Condenser's water side shall be designed and factory pressure tested for not less than [150 psi] [250 psi]. Condenser shall have performance characteristics as indicated on the drawings. Condenser shell shall be constructed of seamless or welded steel. Coil bundles shall be totally removable and arranged to drain completely. Tubes shall be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube shall be individually replaceable, except for the coaxial tubes. Tube baffles shall be properly spaced to provide adequate tube support and cross flow. Performance shall be based on water velocities not less than 3 fps nor more than 12 fps and a fouling factor of[0.00025] [0.0005].

2.6.14 Receivers

Liquid receivers not already specified herein as an integral factory-mounted part of a package, shall be designed, fitted, and rated in accordance with the recommendations of ARI 495, except as modified herein. Receiver shall bear a stamp certifying compliance with ASME BPV VIII Div 1 and shall meet the requirements of ASHRAE 15. Inner surfaces shall be thoroughly cleaned by sandblasting or other approved means. Each receiver shall have a storage capacity not less than 20 percent in excess of that required for the fully-charged system. Each receiver shall be equipped with inlet, outlet drop pipe, drain plug, purging valve, relief valves of capacity and setting required by ASHRAE 15, and two bull's eye liquid-level sight glasses. Sight glasses shall be in the same vertical plane, 90 degrees apart, perpendicular to the axis of the receiver, and not over 3 inches horizontally from the drop pipe measured along the axis of the receiver. In lieu of bull's eye sight glass, external gauge glass with metal glass guard and automatic closing stop valves may be provided.

2.6.15 Chiller Purge System

****

NOTE: Refrigeration systems which operate below atmospheric pressure (i.e., R-123 machines) will require a refrigerant purge piping system. Indicate the routing of the piping on the drawings. Require the Contractor to delete the piping if a purge system is not required for the type of chiller that

is to be provided. Indicate that it will be the Contractor's responsible to size the piping based upon the chiller manufacturer's recommendations. Purge discharge piping may be connected to the pressure-relief piping on the chiller side of the piping's vibration isolators.

****

Chillers which operate at pressures below atmospheric pressure shall be provided with a purge system that operates independently of the chiller. Purge system shall automatically remove air, water vapor, and non-condensible gases from the chiller's refrigerant. Purge system shall condense, separate, and return all refrigerant back to the chiller. An oil separator shall be provided with the purge system if required by the manufacturer. Purge system shall not discharge to occupied areas, or create a potential hazard to personnel. Purge system shall include a purge pressure gauge, number of starts counter, and an elapsed time meter. Purge system shall include lights or an alarm which indicate excessive purge or an abnormal air leakage into chiller.

2.6.16 Tools

One complete set of special tools as recommended by the manufacturer for field maintenance of the system shall be provided. Tools shall be mounted on a tool board in the equipment room or contained in a toolbox as directed by the Contracting Officer.

2.7 ABSORPTION LIQUID CHILLER

****

NOTE: Perform a life cycle cost analysis to determine the most economical type (single- or two-stage) of absorption unit to specify. The initial cost of a two-stage chiller is typically much higher than a single-stage machine, however a two-stage chiller will provide a substantial amount of energy savings over the life of the equipment.

Minimum efficiencies will either be presented in this paragraph or on the design drawings. Delete the efficiency ratings in this paragraph if equipment efficiencies are shown on the drawings. If the efficiencies are shown on the drawings, reference the applicable ARI standard. The following is a list of appropriate minimum full load and part load ratings for absorption chillers. These values or higher values will be entered into the specification where indicated. The designer should contact manufacturers to determine what is available before specifying full and part load values.

	Full Load (*COP)	IPLV (*COP)
Single Effect (Indirect Fired):		

	Full Load (*COP)	IPLV (*COP)
All Capacities	**0.65**	**0.65**
Double Effect (Indirect Fired):		
All Capacities	**1.20**	**1.25**
Double Effect (Direct Fired):		
All Capacities	**0.90**	**0.90**

*** - Units are dimensionless (output / input)**
****

Chiller shall be constructed and rated in accordance with ARI 560 and shall bear the appropriate underwriter's laboratories (UL) label. [Chiller shall have a minimum cooling Coefficient of Performance (COP) of [_____] at full load conditions in accordance with ARI 560. Chiller shall have a minimum cooling COP of [_____] at part load conditions in accordance with ARI 560.] Chiller shall be the [single-stage] [two-stage] hermetic, water-cooled type design. Chiller shall be [indirectly-fired with [steam] [hot water]] [directly-fired with a [single] [dual] fuel burner]. [For direct-fired units, ratings for cooling capacity, fuel consumption, and COP shall be based on the higher heating value (HHV) or the specific type of fuel utilized.] Unless necessary for delivery purposes, chiller shall be assembled, leak-tested, charged, and adjusted at the factory. In lieu of delivery constraints, a chiller may be assembled, leak-tested, charged, and adjusted at the job site by a factory representative. Unit components delivered separately shall be sealed and charged with a nitrogen holding charge. Unit assembly shall be completed in strict accordance with manufacturer's recommendations. Chiller shall operate within capacity range and speed recommended by the manufacturer. Parts weighing 50 pounds or more which must be removed for inspection, cleaning, or repair shall have lifting eyes or lugs. Chiller shall be provided with factory installed insulation on surfaces subject to sweating including the liquid cooler and water boxes. Chiller shall be provided from the factory with a single point wiring connection for incoming power supply. Magnetic across-the-line motor starters with overload protection shall be provided for each factory supplied pump. Chiller shall include all customary auxiliaries deemed necessary by the manufacturer for safe, controlled, automatic operation of the equipment. Chiller shall include the following as a minimum:

a. Absorber, evaporator, and condenser

b. [Generator] [First and second stage generators]

c. Refrigerant, absorber, and inhibitor solutions

d. [Low] [Low and high] temperature heat exchanger(s)

e. Self-contained, hermetically sealed, self lubricating, liquid cooled, refrigerant and solution pumps. Pumps shall be direct coupled with the motor and shall include isolation valves.

f. [Combustion burner assembly and pre-piped fuel train]

g. [Cooling/heating switch valve]

h. [Exhaust gas economizer]

i. Automatic purge system

j. Automatic decrystallization system

k. Chiller controls package

l. Interconnecting piping and wiring

m. [Standard] [Marine] water boxes with [grooved mechanical] [flanged] [welded] connections

n. Refrigerant spray nozzles

o. Factory-mounted welded structural steel base.

p. Thermometers and sight glasses to allow visual inspection of unit operation

2.7.1 Component Construction

****

NOTE: Delete the requirements for the first and second stage generators if a two-effort chiller is not specified.

****

Chiller exterior surfaces shall be factory painted, finished, and insulated as applicable. Chiller shell shall be of seamless or welded steel construction with cast iron or welded steel heads. Evaporator, absorber, condenser, generator(s), and heat exchanger(s) shall be of the shell-and-tube type construction and be in accordance with ASME BPV VIII Div 1. Evaporator, absorber, condenser, and heat exchanger tubes shall be shall be seamless copper or cupronickel (CuNi). [First stage generator tubes shall be seamless carbon steel or type 409 stainless steel. Second stage generator] [Generator] tubes shall be seamless copper-nickel. Tubes shall be individually replaceable. Water boxes shall be provided with lifting lugs, gasketed removable covers, drains, and vents. Unit's internal waterside components shall be rated for not less than 150 psig and factory tested at 150 percent of design working pressure. Factory installed insulation shall be provided for the refrigerant pump, all exposed chilled water piping, the absorber shell, the steam or hot water inlet piping, and the condensate or hot water outlet piping shall be insulated per manufacturer's standard practice. Chiller shall be provided with [standard] [marine] water boxes with [grooved mechanical] [flanged] [welded] connections.

2.7.2 Combustion Burner Assembly

****

NOTE: Delete this paragraph if a direct-fired absorption chiller is not specified.

****

Chiller shall be provided with a forced draft, flame retention type burner and fuel train assembly. Burner shall be the [single] [dual] fuel type capable of burning [natural gas] [propane] [and] [number 1 fuel oil] [number 2 fuel oil] [diesel]. Burner and fuel train shall be listed by the underwriters laboratories (UL). Burner assembly shall be provided with all pressure regulators, switches, controls, ignition system, blower fans, and other devices required for proper and safe operation of the burner. Burner assembly shall be equipped with an external primary-secondary air ratio adjustment that allows adjustment without dismantling the burner. Burner controls shall allow either manual or automatic burner operation. Fuel changeover shall be accomplished [by a manual fuel changeover switch] [automatically as indicated].

2.7.3 Controls Package

Chiller shall be provided with a complete factory mounted and prewired electric or microprocessor based control system. Controls package shall be [unit-mounted] [floor-mounted where indicated] which contains as a minimum a digital display or acceptable gauges, an on-auto-off switch, motor starters, power wiring, control wiring, and disconnect switches. Controls package shall provide operating controls, monitoring capabilities, programmable setpoints, safety controls, and EMCS interfaces as defined below.

2.7.3.1 Operating Controls

Chiller shall be provided with the following adjustable operating controls as a minimum.

a. Leaving chilled water temperature control

b. System capacity control to adjust the unit capacity in accordance with the system load and the programmable setpoints. Controls shall automatically re-cycle the chiller on power interruption.

2.7.3.2 Monitoring Capabilities

During normal operations, the control system shall be capable of monitoring and displaying the following operating parameters. Access and operation of display shall not require opening or removing any panels or doors.

a. Entering and leaving chilled water temperatures
b. Entering and leaving condenser water temperatures
c. Refrigerant and solution temperatures
d. Generator pressures and temperatures
e. Self diagnostic
f. Operation status
g. Operating hours
h. Number of starts
i. Number of purge cycles over the last 7 days

2.7.3.3 Programmable Setpoints

The control system shall be capable of being reprogrammed directly at the unit. No parameters shall be capable of being changed without first entering a security access code. The programmable setpoints shall include the following as a minimum.

a. Leaving Chilled Water Temperature
b. Leaving Condenser Water Temperature
c. Time Clock/Calender Date

2.7.3.4 Safety Controls with Manual Reset

Chiller shall be provided with the following safety controls which automatically shutdown the chiller and which require manual reset.

a. Refrigerant or solution pump thermal or current overload
b. Low refrigerant temperature
c. Loss of chilled water
d. Loss of condenser water
e. High or low condenser water temperatures
f. Power failure
g. Generator high temperature or pressure
h. Low solution level
i. [Burner or related combustion malfunction]

2.7.3.5 Remote Alarm

During the initiation of a safety shutdown, the control system shall be capable of activating a remote alarm bell. In coordination with the chiller, the contractor shall provide an alarm circuit (including transformer if applicable) and a minimum 4 inch diameter alarm bell. Alarm circuit shall activate bell in the event of machine shutdown due to the chiller's monitoring of safety controls. The alarm bell shall not sound for a chiller that uses low-pressure cutout as an operating control.

2.7.3.6 Energy Management Control System (EMCS) Interface

The control system shall be capable of communicating all data to a remote integrated DDC processor through a single shielded cable. The data shall include as a minimum all system operating conditions, capacity controls, and safety shutdown conditions. The control system shall also be capable of receiving at a minimum the following operating commands.

a. Remote Unit Start/Stop
b. Remote Chilled Water Reset
c. Remote Condenser Water Reset

2.8 ACCESSORIES

2.8.1 Pumps

****

NOTE: Indicate on the drawings pump capacity, efficiencies, motor sizes, and impeller types. Typical impeller types include the double-suction horizontal split-case type, end-suction vertical split-case type, close-coupled end-suction type, close-coupled in-line type.

****

Pumps shall be the electrically driven, non-overloading, centrifugal type which conform to HI 1.1-1.5. Pump capacity, efficiency, motor size, and impeller type shall be as indicated on the drawings. Pumps shall be selected at or near peak efficiency. Pump curve shall rise continuously from maximum capacity to shutoff. Pump motor shall be totally enclosed and have sufficient horsepower for the service required. Each pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in the cover.

2.8.1.1 Construction

****

NOTE: In most cases, mechanical shaft seals will be the preferred type of shaft seal rather than the stuffing-box type. Although less costly in many cases, the stuffing-box type seals require periodic maintenance rendering the seals economical typically only for very large pumps where the first cost difference is great. The designer should make an economic shaft seal selection based on life cycle cost.

****

Shaft seal shall be mechanical-seal or stuffing-box type. Impeller shall be statically and dynamically balanced. Each pump casing shall be designed to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than 125 psig. Pump casing and bearing housing shall be close grained cast iron. High points in the casing shall be provided with manual air vents; low points shall be provided with drain plugs. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Shaft shall be carbon or alloy steel, turned and ground. Bearings shall be ball-bearings, roller-bearings, or oil-lubricated bronze-sleeve type bearings, and be efficiently sealed or isolated to prevent loss of oil or entrance of dirt or water. [Pump and motor shall be mounted on a common cast iron base having lipped edges and tapped drainage openings or structural steel base with lipped edges or drain pan and tapped drainage openings.] [Pump shall be provided with shaft coupling guard.] [Close coupled pumps shall be provided with drip pockets and tapped openings.] Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pump speed shall not exceed 3,600 rpm, except where the pump head is less than 60 feet of water, the pump speed shall not exceed 1,750 rpm. Pump shall be accessible for servicing without disturbing piping connections.

2.8.1.2 Mechanical Shaft Seals

Seals shall be single, inside mounted, end-face-elastomer bellows type with stainless steel spring, brass or stainless steel seal head, carbon rotating face, and tungsten carbide or ceramic sealing face. Glands shall be bronze and of the water-flush design to provide lubrication flush across the face of the seal. Bypass line from pump discharge to flush connection in gland shall be provided, with filter or cyclone separator in line.

2.8.1.3 Stuffing-Box Type Seals

Stuffing box shall include minimum 4 rows of square, impregnated TFE (Teflon) or graphite cord packing and a bronze split-lantern ring. Packing gland shall be bronze interlocking split type.

2.8.2 Expansion Tanks

****

NOTE: Designer will indicate the location and size of each expansion tank on the drawings.

****

Expansion tanks shall be welded steel, constructed, tested and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 125 [_____] psig and precharged to the minimum operating pressure. Expansion tanks shall have a replaceable diaphragm and be the captive air type. Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with an air charging valve. Tanks shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

2.8.3 Air Separator Tanks

****

NOTE: The designer will indicate the location and the minimum size of each air separator on the drawings.

****

External air separation tank shall be steel, constructed, tested, and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of [125] [_____] psig.

2.8.4 Refrigerant Leak Detector

****

NOTE: Refrigerant leak detectors will be provided as required by the "System Application Requirements" in ASHRAE 15.

When a detector is required, the location will be indicated on the drawings. Detectors are best located between the refrigeration system and the room exhaust. Sampling points from a detector will be located a maximum of 18 inches above the finished floor since all commonly-used refrigerants are heavier than air.

As a rule of thumb, the distance between any refrigeration system and a refrigerant sampling point shouldn't exceed 50 feet. In order to meet the recommended 50 foot distance, a mechanical room can be provided with either multiple detectors each with single sampling points or with one detector that has the capability of monitoring at multiple sampling points. If multiple sampling points are required, enter the number in the appropriate blank below.

Per ASHRAE 15, when a detector senses refrigerant it must activate an alarm and initiate the room ventilation system. In regards to alarms, as a

minimum, indicate that the detector will energize a light on or near the detector as well as a second light installed on the outside wall next to the mechanical room entrance. The exterior light will be provided with a sign that warns personnel entering the mechanical room of a refrigerant release and that a SCBA is required to enter. If applicable to the installation, include an audible alarm on the exterior of the mechanical room. Include the electrical design for the alarm system on the drawings.

As an additional item, ASHRAE 15 states that open-flame devices (i.e., boilers, etc.) cannot be installed in the same area as a refrigeration system, unless either combustion air for the open-flame device is ducted straight from outside to the device; or the alarm relay from the detector is used to automatically shutdown the combustion process in the event of refrigerant leakage. Indicate all applicable alarm controls on the drawings.

Delete the information in the last bracketed sentences if an EMCS is not applicable to the design.
****

Detector shall be the continuously-operating, halogen-specific type. Detector shall be appropriate for the refrigerant in use. Detector shall be specifically designed for area monitoring and shall include [a single sampling point] [_____ sampling points] installed where indicated. Detector design and construction shall be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector shall have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Detector shall be supplied factory-calibrated for the appropriate refrigerant(s). Detector shall be provided with an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant(s) in use. The detector's relay shall be capable of initiating corresponding alarms and ventilation systems as indicated on the drawings. Detector shall be provided with a failure relay output that energizes when the monitor detects a fault in its operation. [Detector shall be capable with the facility's energy management and control system (EMSS). The EMCS shall be capable of generating an electronic log of the refrigerant level in the operating area, monitoring for detector malfunctions, and monitoring for any refrigerant alarm conditions.]

2.8.5 Refrigerant Relief Valve/Rupture Disc Assembly

****
NOTE: ASHRAE 15 requires refrigeration systems to be protected with a pressure-relief device that will safely relieve pressure due to fire or other abnormal conditions. A relief valve/rupture disc assembly is the optimum solution. The rupture disc

will provide visual indication of a release while also providing immediate shutoff once a safe pressure is achieved.

Designer will indicate on the drawings the location of each new relief valve/rupture disc assembly as well as the routing and size of corresponding pressure-relief piping. The routing and size of new pressure-relief piping will be per ASHRAE 15.

****

The assembly shall be a combination pressure relief valve and rupture disc designed for refrigerant usage. The assembly shall be in accordance with ASME BPV IX and ASHRAE 15. The assembly shall be provided with a pressure gauge assembly which will provide local indication if a rupture disc is broken. Rupture disc shall be the non-fragmenting type.

2.8.6 Refrigerant Signs

Refrigerant signs shall be a medium-weight aluminum type with a baked enamel finish. Signs shall be suitable for indoor or outdoor service. Signs shall have a white background with red letters not less than 0.5 inches in height.

2.8.6.1 Installation Identification

Each new refrigerating system shall be provided with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.
b. Refrigerant number and amount of refrigerant.
c. The lubricant identity and amount.
d. Field test pressure applied.

2.8.6.2 Controls and Piping Identification

Refrigerant systems containing more than 110 lb of refrigerant shall be provided with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow [, the ventilation system,] and the refrigerant compressor(s).
b. Pressure limiting device(s).

2.8.7 Refrigerant Recovery/Recycle System

****

NOTE: A refrigerant recovery/recycle system will not be specified if the designer determines that on site staff will not be responsible for chiller teardown or major service. If the designer determines the on site staff will be responsible for chiller teardown or major service, the designer shall investigate whether another recovery/recycle system is available to maintenance personnel before specifying a new system. The recovery/recycle system is an expensive item and all alternatives to providing a new system should be investigated.

If a refrigerant recovery/recycle system is specified, the recovery/recycle system shall be tested and listed to conform to the requirements of ARI 740 for refrigerant recovery/recycle systems by a recognized national testing laboratory. The system shall include separate storage vessel(s) capable of storing the entire refrigerant charge of the largest chiller.

The recovery/recycle unit shall be portable. Chiller mounting or floor mounting of the system is expensive and therefore is discouraged.

****

A manually initiated refrigerant recovery/recycle system shall be provided, consisting of a motor-driven, air- or water-cooled, reciprocating condensing unit and a receiver of sufficient capacity to store the entire refrigerant charge of the largest water-chilling system. For refrigerants with atmospheric pressure boiling temperature below 68 degrees F, the receiver shall be sized so that it is no more than 80 percent full at 90 degrees F. For refrigerants with atmospheric pressure boiling temperature above 68 degrees F, the receiver shall be sized so that it is no more than 90 percent full at 90 degrees F. The recovery/recycle system condensing unit shall be assembled as a complete unit and meet the requirements of ASHRAE 15. The system components shall be portable and shall include all valves, connections, and controls required for operation. Receiver and relief devices shall conform to the requirements of ASME BPV VIII Div 1. The recovery/recycle system shall be tested and listed to conform to ARI 740 for refrigerant recovery/recycle systems by a recognized national testing laboratory. For refrigerants with atmospheric pressure boiling temperature below 68 degrees F, the recovery/recycle unit shall have an ARI 740 vapor refrigerant recovery rate of no less than 17.0 lb/minute. For refrigerants with atmospheric pressure boiling temperature above 68 degrees F, the recovery/recycle unit shall have an ARI 740 vapor refrigerant recovery rate of no less than 2.2 lb/minute.

2.8.8 Automatic Tube Brush Cleaning System

****

NOTE: Condensing steam-turbine-driven machines, with refrigeration and steam condensing water flows in series, must be unloaded prior to condenser water flow reversal. In this, the designer will investigate the availability of controllers to unload the machine prior to flow reversal and mark up the specification accordingly.

Water flow diverters bypass approximately 3 percent of the total condenser water flow around the condenser. The designer will investigate condenser water bypass requirements and size the condenser water pumps and the chiller for the corrected condenser water flow.

****

2.8.8.1   Brush and Basket Sets

One brush and basket set (one brush and two baskets) shall be furnished for each condenser tube. Brushes shall be made of nylon bristles, with titanium wire. Baskets shall be polypropylene.

2.8.8.2   Flow-Diverter Valve

Each system shall be equipped with one flow-diverter valve specifically designed for the automatic tube brush cleaning system and have parallel flow connections. The flow-diverter valve shall be designed for a working pressure of [150] [250] psig.End connections shall be flanged. Each valve shall be provided with an electrically operated air solenoid valve and position indicator.

2.8.8.3   Control Panel

The control panel shall provide signals to the diverter valve at a preset time interval to reverse water flow to drive the tube brushes down the tubes and then signal the valve to reverse the water flow to drive the brushes back down the tubes to their original position. The controller shall have the following features as a minimum:

a. Timer to initiate the on-load cleaning cycle.
b. Manual override of preset cleaning cycle.
c. Power-on indicator.
d. Diverter-position indicator.
e. Cleaning-cycle-time adjustment
f. Flow-switch bypass.

2.8.9   Field Installed Insulation

Field installed insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except for header and waterbox insulation which shall be flexible cellular insulation in accordance with ASTM C 534, Type I.

2.8.10   Gaskets

Gaskets shall conform to ASTM F 104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

2.8.11   Bolts and Nuts

Bolts and nuts, except as required for piping applications, shall be in accordance with ASTM A 307. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A 307.

2.9   COOLING TOWER

****

NOTE: Locate the tower in accordance with NFPA 214, and determine the extent and type of fire protection required for all size towers using the factors indicated in NFPA 214. Concrete structured towers are selected for their longevity over conventional type, but are considerably more expensive and should be used only if cost effective. PVC fill for

concrete towers is considerably less expensive and should be specified unless tile fill can be justified. When project requirements limit the use of wood construction in cooling towers, all references to wood construction will be removed.
****

2.9.1 Fire Safety

Towers shall conform to NFPA 214. Fire hazard rating for plastic impregnated materials shall not exceed 25. Plastics shall not drip or run during combustion. Determine ratings by ASTM E 84 or NFPA 255.

2.9.2 Lumber

Lumber required for cooling tower construction shall be as defined by the following type woods:

2.9.2.1 Douglas Fir

CTI Std-114, WWPA Grading Rules, Grade B and better, Industrial Clear. Douglas fir shall have a preservative treatment in accordance with CTI WMS-112.

2.9.2.2 Plywood

CTI Std-134, Exterior Grade, type and thickness as specified for the application.

2.9.2.3 Pressure Treated Lumber

Pressure treated lumber shall be in accordance with CTI WMS-112. Wood exposed as the result of notching, cutting, or drilling shall be saturated with the preservative.

2.9.2.4 Redwood

CTI Std-103, CRA RIS-01-SS California Redwood, clear of all hearts.

2.9.3 Fiberglass Reinforced Plastic (FRP)

FRP components shall be inert, corrosion resistant, and fire-retardant with a thickness of 12 ounces per square foot. FRP components shall contain an ultraviolet (UV) ray inhibitor as per CTI Std-137, Grade 1 or 3.

2.9.4 Zinc-Coated Steel

Components fabricated of zinc-coated steel shall be not lighter than 16 gauge steel, protected against corrosion by a zinc coating. The zinc coating shall conform to ASTM A 153/A 153M and ASTM A 123/A 123M, as applicable and have an extra heavy coating of not less than 2-1/2 ounces per square foot of surface. Galvanized surfaces damaged due to welding shall be coated with zinc rich coating conforming to ASTM D 520, Type 1.

2.9.5 Polyvinyl Chloride (PVC) Formed Sheets

ASTM D 1784, Type I, Grade 1 with a flame spread rating of 15 or less per ASTM E 84.

2.9.6 Hardware

Bolts shall be cadmium-plated, zinc-coated steel, or Type 304 stainless steel. Each bolt shall be provided with neoprene and cadmium-plated steel washers under the heads. Nails shall be silicon bronze, commercial bronze, or stainless steel. Hardware shall meet the salt-spray fog test as defined by ASTM B 117.

2.9.7 Noise Control

****

NOTE: Where cooling towers are in the proximity of residential, administrative, medical, or similar inhabited facility, the maximum acceptable noise limits for such applications should be determined in NC level or dBA, and coordinated with local code requirements and the cooling tower manufacturer. The noise level criteria should be scheduled on the drawing.

****

Sound power levels (in decibels with a reference pressure of 0.0002 microbar) of the cooling tower shall not exceed the maximum permitted decibel levels for the designated octave band as set forth in the following tables. Sound power level data for the cooling tower shall be based on tests conducted in accordance with ANSI S1.13.

Octave Band (in Hz)	63	125	250	500	1000	2000	4000	8000
Sound Power Level in dB	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]

2.9.8 Conventional Type Tower

a. Factory-Assembled: Each tower shall be the induced mechanical draft, [crossflow] [or] [counterflow], factory fabricated, factory-assembled type.

b. Field-Assembled: Each tower shall be the induced mechanical draft, [crossflow] [or] [counterflow], factory fabricated, field-assembled type. Notching structural members may be permissible only if the members are increased proportionately in size to provide equivalent strength. Framework design for wood towers shall conform to requirements of CTI Std-103 for redwood construction and CTI Std-114 for douglas fir construction.

2.9.8.1 Casing

****

NOTE: Delete the last two sentence if inapplicable.

****

Casing shall be constructed of [zinc-coated steel] [lumber] [Type 304 stainless steel] [FRP]. Towers shall be designed and constructed to withstand a wind pressure of not less than 30 pound-force per square foot (psf) on external surfaces. Fan decks shall be designed to withstand a live load of not less than [40] [60] psf in addition to the concentrated or distributed loads of equipment mounted on the fan decks. A 15-percent increased loading shall be included for ice or snow load. Air inlet and discharge terminations shall have flanged or lipped projections for connecting ductwork.

2.9.8.2 Cold-Water Basin

Basin shall be completely watertight and constructed of [1-1/2 inch tongue and groove lumber] [concrete in accordance with Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE, 2,500 psi Class and reinforced as indicated.] [Type 304 stainless steel] [FRP]. Basin shall be constructed and installed to ensure that air will not be entrained in outlets when operating and no water will overflow on shutdown. Each individual sump shall be provided with an individual outlet. Each outlet shall be provided with a 1/2 inch mesh, zinc-coated steel wire securely mounted to prevent trash from entering the outlet. Each basin shall be provided with overflow and valved drain connections. Each basin shall be provided with a float-controlled, makeup water valve as indicated. The makeup water shall discharge not less than 2 inches or two pipe diameters, whichever is greater, above the top of the basin.

2.9.8.3 Hot-Water Distribution

Design water distribution systems for each cell of each tower so that a water flow of 140 percent of specified water flow will not cause overflowing or splashing. Water distribution systems shall be accessible and permit flexibility of operation. Provide removable covers of same material and thickness as casing for entire water distribution basin. Support covers by basin sides with top of cover flush with top of basin. Provide separate regulation and stop valves for complete balancing and complete shutoff from each cell. Systems shall be self-draining and nonclogging. The water distribution system shall be either one of the following types.

a. Open Basins: Basins shall be provided with a splash box or baffles to minimize splashing of incoming hot water, holes that evenly distribute the water over the entire decking area, and a basin cover. Holes used in a water basin shall be provided with ceramic or plastic orifice inserts.

b. Spray Nozzles: Spray nozzles shall be cleanable; stainless steel, bronze, or high-impact plastic, nonclogging, removable; and, spaced for even distribution.

2.9.8.4 Fill Material

The fill shall be the following materials as specified. PVC formed sheets arranged in a honeycomb or waveform configuration; zinc-coated steel treated Douglas-fir; or treated hemlock and treated redwood. Zinc-coated steel shall have a minimum of 2.5 ounces per square foot of surface. Fill material shall be free to expand or contract without warping. PVC fill shall not be provided when inlet temperatures exceed 125 degrees F. No plasticized wood cellulose shall be provided for fill material. Fill shall be removable or otherwise made accessible for cleaning. Provide space supports as required to prevent sagging and misalignment, and provide for an even mixing of air and water.

2.9.8.5 Drift Eliminator

Provide in tower outlet to limit drift loss to not over 0.02 percent of specified water flow. Eliminators shall be constructed of not less than 3/8 inch lumber or polyvinyl chloride (PVC).

2.9.8.6 Fan Cylinder

Each fan shall be mounted in a fan cylinder to elevate the fan discharge air. Total extension height shall not exceed the fan diameter. Fan cylinders shall be constructed of zinc-coated steel, lumber, Type 304 stainless steel, or FRP and be compatible with the entire tower construction. Each fan cylinder shall be provided with a zinc-coated steel 12 gauge wire mesh securely mounted to the top of the cylinder in accordance with manufacturer's recommendations.

2.9.8.7 Framework and Equipment Supports

Framework and equipment supports shall be zinc-coated steel [, Type 304 stainless steel,] [FRP,] or lumber. Materials provided for framework, casings and equipment supports shall be compatible.

2.9.8.8 Structural Supports

Structural supports shall be provided in accordance with the recommendations of the manufacturer of the tower unless otherwise indicated.

2.9.8.9 Foundations

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NOTE: For the design of a tower foundation, indicate the location, the size, the reinforcement requirements, etc. necessary for a cooling tower available from three commonly known manufacturers. For small retrofit type jobs the designer may choose to show the general layout of the foundation and rely on the Contractor to design and construct the foundation based on the cooling tower to be provided. Delete the last two sentences of the paragraph if the foundation is not to be designed by the Contractor.

****

Cooling tower foundations shall meet the requirements of the cooling tower manufacturer and be as indicated. Foundation design shall be based on the load conditions and soil bearing value indicated. Foundation calculations shall be submitted with the equipment drawings.

2.9.9 Concrete Structured Type

Each tower shall be the induced mechanical draft, counterflow, factory fabricated, field-assembled type.

2.9.9.1 Casing

The wall sections shall be constructed of air entrained concrete mix. Concrete shall conform to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Exposed concrete shall be rub-finished for smooth and uniform surfaces free of form marks and defects. Honeycomb concrete shall not be permitted. Any cold-pour joints in vertical walls shall have a continuous water-stop stripping of molded polyvinyl plastic (6 inch dumbbell).

2.9.9.2 Cold-Water Basin

Basin floor slab shall be a continuous pour of high density air entrained concrete. The mix shall be of a strength to test a minimum of 4,000 psi (28 days) compressive. Air entrained cement, conforming to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE shall be used throughout the tower structure. Structure shall contain the reinforcing steel as detailed. Standard curing measures shall be carried out to protect the concrete while "green". Exposed concrete shall be rub-finished for smooth and uniform surfaces free of form marks and defects. Honeycomb concrete shall not be permitted. A continuous water-stop stripping of molded polyvinyl plastic (6 inch dumbbell) shall be located on the centerline position of the basin wall section/floor slab intersection, and at all other cold pour joints. Basin wall sections shall be made in a second continuous pour, contain the necessary reinforcing steel as submitted by the manufacturer and approved, and be arranged to interlock with the water-stop seal in the floor slab, forming a completely waterproof basin.

2.9.9.3 Hot-Water Distribution

Distribution system for each cell shall consist of a centrally located header complete with junction boxes, side laterals, fittings, and nozzles. Piping shall be either cast iron, ductile iron, threaded-glass-fiber reinforced epoxy pipe, polypropylene, PVC or Schedule 80 black steel. Junction boxes shall be cast iron and nozzles shall be brass, stainless steel or plastic. Distribution piping including spray nozzles, pipe, fittings, and junction boxes shall be provided complete to flange face located at a point 6 inches below top of fill support beam. Provisions shall be provided for balancing of water flow between cells or spray trees.

2.9.9.4 Fill Material

Fill material shall be [tile of multicell design, set without mortar] [or] [PVC formed sheets], in a pattern, and of sufficient height to meet the performance specifications. [Tile fill shall be vitreous, with a low water absorption that will pass a freeze-thaw test conducted in accordance with ASTM C 67. Tile fill shall have a minimum crushing strength of 2,000 psi over the gross area of the tile when the load is applied parallel to the cells as tested in accordance with ASTM C 67. Cast iron tee section lintels supporting the tile fill shall conform to ASTM A 48,ASTM A 48M, Class 25, 1/8 inch additional thickness for corrosion. Lintels shall be designed with a safety factor of 2 minimum.] [PVC fill shall be manufactured from minimum nominal [20] [15] mil sheets. PVC fill shall be supported by the tower structure using corrosion resistant members. PVC sheets shall be arranged in a honeycomb or waveform configuration and shall have a flame spread rating of 25 or less when tested in accordance with ASTM E 84. Fill material shall be free to expand or contract without warping or cracking.]

2.9.9.5 Drift Eliminators

Eliminators shall be of the multi-pass zigzag type, assembled into sections making a strong, stable unit. Provide in tower outlet to limit drift loss to not over 0.005 percent of the water flow. These sections shall be supported on PVC or FRP tee sections. Tee sections shall be suspended with 1/4 inch brass rods connected to stainless steel clips embedded in the bottom side of the roof deck at the time of casting. Stainless steel clips shall be supplied by cooling tower manufacturer for installation by Contractor at time of roof deck pour. Eliminators may be supported by brass or stainless steel suspension rods from the fan deck or supported directly on concrete beams. Eliminators may be either PVC extruded sections or wave formed sheets of PVC resin conforming to ASTM D 1784 Type I, Grade 2. Eliminators and supporting framework shall have flame spread rating of 25 or less when tested in accordance with ASTM E 84.

2.9.9.6 Fan Decks and Stacks

Construct fan decks of precast, reinforced lightweight concrete, in multiple sections, forming a complete, vibration-free base for mounting fan, speed reducer, drive shaft, motor, and fan stacks. Construct fan stacks of precast, reinforced lightweight concrete in multiple sections, constrained with bands of zinc-coated steel conforming to ASTM A 123/A 123M, not less than 1/8 x 3 inches, and bolted to form a compressive load on stack perimeter. Secure stack in place on fan deck with Class A mortar.

2.9.10 Louvers

Air inlets for each cooling tower shall be provided with individually removable louvers arranged to prevent the escape of water. Louvers shall be zinc-coated steel, [Type 304 stainless steel,] [FRP,] or lumber. Materials provided for casings and louvers shall be compatible; one material shall not produce stains upon the other. Louvers constructed of lumber shall be of a thickness to withstand alternate wetting and drying without cracking or splitting. Air intakes shall be provided with 1 inch zinc-coated steel mesh.

2.9.11 Fans

****

NOTE: When the density of the ambient air to be handled by the fans differs substantially from the density of the standard air value of 1.2 kg per cubic m (0.075 pound per cubic foot) at 21 degrees C (70 degrees F) and 101 kPa (29.92 inches mercury), the density of the air and/or the elevation above mean sea level will be stated.

****

Fans shall be the [centrifugal] [or] [adjustable-pitch propeller] type, constructed of zinc-coated steel, Type 304 stainless steel, aluminum or an aluminum alloy, or FRP. Propeller type shall have a maximum tip speed of 11,000 fpm. Fan blade assembly shall be both statically and dynamically balanced after assembly of the cooling tower. Fan hub shall be constructed of [zinc-coated steel] [stainless steel] [cast aluminum] with adequate surface protection against corrosion. Complete fan assembly (fan and mounting) shall be designed to give maximum fan efficiency and long life when handling saturated air at high velocities.

2.9.12 Speed Reducer Gears and Drive Shaft

****

NOTE: Double reduction gear reducer should be considered where low noise requirement is a factor.

****

Speed reducer gears shall be rated in accordance with CTI Std-111. Gear reducers shall be of the [spiral bevel, single reduction] [spiral or helical, double reduction] type. Reducer shall be mounted in accordance with manufacturer's recommendations. Each reducer shall be provided with an oil level cutoff switch interlocked to the fan motor. Each reducer shall be provided with an oil level sight glass, fill, drain, and vent lines located in a readily accessible position. Drive shafts shall be the full floating type with flexible couplings at both ends and have a service factor of 1.0 or greater. Drive shafts shall be of stainless steel, fitted each end with flexible couplings (stainless steel plate type). Each drive shaft shall be provided with a galvanized steel guard, to prevent damage to surrounding equipment in case of shaft failure. Provision shall be made for lubrication of all bearings. Bearings shall be accessible to the extent that each bearing can be lubricated without dismantling fan.

2.9.13 Fan Motor

****
NOTE: Delete the last sentence if inapplicable.
****

Each motor shall be a [single speed] [two speed], totally enclosed, insulation Class B, NEMA Design B, continuous-rated, and conforming to NEMA MG 1. Fan motors shall have [open] [dripproof] [totally enclosed] [explosion proof] enclosures and be located outside the discharge airstream. Motors shall be mounted according to manufacturer's recommendations. Two-speed motors shall have a single winding with variable torque characteristics.

2.9.14 Stairways and Ladders

Provide stairs, 60-degree ship ladders or straight-rung ladders of standard design, starting at [ground] [roof] level and extending as high as required to gain access to fan decks and water distribution systems. Stairways and ladders shall be hot-dip, zinc-coated steel. Ladders higher than 12 feet shall have a safety cage.

2.9.15 Handrailings

Steel handrailings shall be not less than 42 inches high around the exterior of each working surface that is 12 feet or more above the ground, roof, or other supporting construction. Railings shall be not smaller than 1-1/4 inch zinc-coated steel pipe with standard zinc-coated steel railing.

2.9.16 Access Doors

Each tower shall be provided with access doors at grade level to provide entry to the interior for service maintenance without removal of the fill. Doors shall be provided with doors on each endwall of each cooling tower cell. Frame and brace access doors to prevent damage when opening and closing. Doors shall be located adjacent to float controls.

2.10 WATER TREATMENT SYSTEMS

When water treatment is specified, the use of chemical-treatment products containing hexavalent chromium (Cr) is prohibited.

2.10.1 Water Analysis

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NOTE: A water analysis may be available from the user. If an analysis is not available, an analysis will be performed during the design, and appropriate data will be entered.

****

Conditions of make-up water to be supplied to the condenser and chilled water systems are as follows:

Date of Sample	[_____]
Temperature	[_____] degrees F.
Silica (SiO 2)	[_____] ppm (mg/1)
Insoluble	[_____] ppm (mg/1)
Iron and Aluminum Oxides	[_____] ppm (mg/1)
Calcium (Ca)	[_____] ppm (mg/1)
Magnesium (Mg)	[_____] ppm (mg/1)
Sodium and Potassium (Na and K)	[_____] ppm (mg/1)
Carbonate (HCO 3)	[_____] ppm (mg/1)
Sulfate (SO 4)	[_____] ppm (mg/1)
Chloride (Cl)	[_____] ppm (mg/1)
Nitrate (NO 3)	[_____] ppm (mg/1)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] epm (meq/1)
Non-Carbonate Hardness	[_____] epm (meq/1)
Total Hardness	[_____] epm (meq/1)
Dissolved Solids	[_____] ppm (mg/1)
Fluorine	[_____] ppm (mg/1)
Conductivity	[_____] micrmho/cm

2.10.2 Chilled and Condenser Water

Water to be used in the chilled and condenser water systems shall be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.

2.10.3 Glycol Solution

****

NOTE: If freeze protection for chilled water is not required, this paragraph should be deleted. When a glycol system is used, the size of the HVAC systems should be corrected due to changes in specific heat and viscosity. ASHRAE's "HVAC systems and Equipment Handbook" should be consulted for the appropriate calculation procedures. Ethylene glycol should be used for HVAC systems. However, if the heat transfer media has the possibility of mixing with a potable water system, propylene glycol should be used. The required concentration should be entered based upon the anticipated ambient or operating temperature.

****

A [_____] percent concentration by volume of industrial grade [ethylene] [propylene] glycol shall be provided for the system. The glycol shall be tested in accordance with ASTM D 1384 with less than 0.5 mils penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicate based inhibitors shall not be used. The solution shall be compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.

2.10.4   Water Treatment Services

****

NOTE: The services of a water treatment company to treat a chilled water system should only be required if the makeup water available is of very poor quality.

****

The services of a company regularly engaged in the treatment of [condenser] [condenser and chilled] water systems shall be used to determine the correct chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company shall maintain the chemical treatment and provide all chemicals required for the [condenser] [condenser and chilled] water systems for a period of 1 year from the date of occupancy. The chemical treatment and services provided over the 1 year period shall meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Acid treatment and proprietary chemicals shall not be used.

2.10.5   Chilled Water System

****

NOTE: For dual temperature systems (chilled and heated water), coordinate the compatibility of the separate water treatment systems.

****

A shot feeder shall be provided on the chilled water piping as indicated. Size and capacity of feeder shall be based on local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.10.6   Condenser Water

****

NOTE: Cooling towers with a capacity of greater than 176 kW (50 tons) will be provided with automatic chemical feed and blow down systems. Smaller towers will be provided with continuously activated systems. Indicate the location of the entire water treatment system. Delete all the information under this paragraph if a cooling tower is not used in the system.

****

The water treatment system shall be capable of [automatically] [continuously] feeding chemicals and bleeding the system to prevent corrosion, scale, and biological formations. [Automatic chemical feed systems shall automatically feed chemicals into the condenser water based on varying system conditions.] [Continuous chemical feed systems shall continuously feed chemicals into the condenser water at a constant rate. The system shall be initially set manually based on the water analysis of the make-up water.]

2.10.6.1 Chemical Feed Pump

One pump shall be provided for each chemical feed tank. The chemical feed pumps shall be positive displacement diaphragm type. The flow rate of the pumps shall be adjustable from 0 to 100 percent while in operation. The discharge pressure of pumps shall not be less than 1.5 times the line pressure at the point of connection. The pumps shall be provided with a pressure relief valve and a check valve mounted in the pump discharge.

2.10.6.2 Tanks

Two chemical tanks shall be provided. The tanks shall be constructed of [high density polyethylene] [stainless steel] with a hinged cover. The tanks shall have sufficient capacity to require recharging only once per 7 days during normal operation. A level indicating device shall be included with each tank. An electric agitator shall be provided for each tank.

2.10.6.3 Injection Assembly

An injection assembly shall be provided at each chemical injection point along the condenser water piping as indicated. The injection assemblies shall be constructed of stainless steel. The discharge of the assemblies shall extend to the centerline of the condenser water piping. Each assembly shall include a shutoff valve and check valve at the point of entrance into the condenser water line.

2.10.6.4 Water Meter

Water meters shall be provided with an electric contacting register and remote accumulative counter. The meter shall be installed within the make-up water line, as indicated.

2.10.6.5 Timers

Timers shall be of the automatic reset, adjustable type, and electrically operated. The timers shall be suitable for a 120 volt current. The timers shall be located within the water treatment control panel.

2.10.6.6 Water Treatment Control Panel

****

NOTE: The MAN-OFF-AUTO switch should be deleted for continuously fed systems. In areas where a panel could come in contact with the water treatment chemical, choose the stainless steel construction.

****

The control panel shall be a NEMA 12 enclosure suitable for surface mounting. The panel shall be constructed of [stainless steel] [steel] with a hinged door and lock. The panel shall contain a laminated plastic nameplate identifying each of the following functions:

(1) Main power switch and indicating light
(2) MAN-OFF-AUTO selector switch
(3) Indicating lamp for bleed-off valve
(4) Indicating lamp for each chemical feed pump
(5) Set point reading for each timer

2.10.6.7 Chemical Piping

The piping and fittings shall be constructed of [schedule 80 PVC] [stainless steel] suitable for the water treatment chemicals.

2.10.6.8 Sequence of Operation

****

NOTE: Choose the first set of brackets for automatic chemical feed systems. Choose the second set of brackets for continuous chemical feed systems.

****

[The chemicals shall be added based upon sensing the make-up water flow rate and activating appropriate timers. A separate timer shall be provided for each chemical. The blow down shall be controlled based upon the make-up water flow rate and a separate timer.] [The system shall contain an adjustable valve for continuous blow down. The flow rate from the appropriate chemical tanks shall be manually set at the metering pump for continuous chemical feed.] The injection of the chemical required for biological control shall be controlled by a timer which can be manually set for proper chemical feed. All timer set points, blow down rates, and chemical pump flow rates shall be determined and set by the water treatment company.

2.10.6.9 Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided.

2.10.6.10 Bleed Line

****

NOTE: Delete the following paragraph on bleed lines if an automatic chemical system is chosen.

****

A bleed line with a flow valve of the needle-valve type sized for the flow requirement or fixed orifice shall be provided in the pump return to the tower. The bleed line shall be extended to the nearest drain for continuous discharge.

2.11 PIPING COMPONENTS

2.11.1 Water Piping and Fittings

2.11.1.1 Steel Pipe

Steel pipe shall conform to ASTM A 53, Schedule 40, Type E or S, Grades A or B. Type F pipe shall not be used.

2.11.1.2 Steel Pipe Joints and Fittings

Joints and fittings shall be welded, flanged, threaded, or grooved as indicated. If not otherwise indicated, piping 1 inch and smaller shall be threaded; piping larger than 1 inch and smaller than 3 inches shall be either threaded, grooved, or welded; and piping 3 inches and larger shall be grooved, welded, or flanged. Rigid grooved mechanical joints and fittings may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 230 degrees F. Flexible grooved joints shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein. The manufacturer of each fitting shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

a. Welded Joints and Fittings: Welded fittings shall conform to ASTM A 234/A 234M, and identified with the appropriate grade and marking symbol. Butt-welding fittings shall conform to ASME B16.9. Socket-welding and threaded fittings shall conform to ASME B16.11.

b. Flanged Joints and Fittings: Flanges shall conform to ASTM A 181/A181M and ASME B16.5 Class 150. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. This gaskets shall contain aramid fibers bonded with styrene butadeine rubber (SBR) or nitrile butadeine rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.5. Bolts shall be high or intermediate strength material conforming to ASTM A 193/A 193M.

c. Threaded Joints and Fittings: Threads shall conform to ASME B1.20.1. Pipe nipples shall conform to ASTM A 733, type and material to match adjacent piping. Unions shall conform to ASME B16.39, type as required to match adjacent piping.

d. Dielectric Unions and Flanges: Dielectric unions shall have the tensile strength and dimensional requirements specified. Unions shall have metal connections on both ends threaded to match adjacent piping. Metal parts of dielectric unions shall be separated with a nylon insulator to prevent current flow between dissimilar metals. Unions shall be suitable for the required operating pressures and temperatures. Dielectric flanges shall provide the same pressure ratings as standard flanges and provide complete electrical isolation.

e. Grooved Mechanical Joints and Fittings: Joints and fittings shall be designed for not less than 125 psig service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47,ASTM A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming ASTM A 106, Grade B or ASTM A 53. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 230 degrees F or Grade No. M3BA610A15B44Z for circulating medium up to 200 degrees F. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

2.11.1.3   Copper Tube

Copper tubing for water service shall conform to ASTM B 88,ASTM B 88M, Type K or L.

2.11.1.4   Copper Tube Joints and Fittings

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.11.2   Water Piping Valves and Accessories

Valves shall be rated for Class 125 and shall be suitable for operating temperature of 250 degrees F. Valves shall be suitable for the working pressure of the pipe in which installed. Valves shall meet the material, fabrication and operating requirements of ASME B31.1. Chain operators shall be provided for valves located 10 feet or higher above the floor. Valves in sizes larger than 1 inch and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be provided by the same manufacturer as the grooved pipe joint and fitting system.

2.11.2.1   Gate Valves

Gate valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with rising stem and threaded, soldered, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70, Type I, II, Class 125, Design OF and shall be cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.11.2.2   Globe and Angle Valves

Globe and angle valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Globe and angle valves 3 inches and larger shall conform to MSS SP-85 and shall be cast iron with bronze trim and flanged or threaded ends.

2.11.2.3   Check Valves

Check valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Check valves 3 inches and larger shall conform to MSS SP-71, Type I, II, III, or IV, Class 125 or 150 and shall be cast iron with bronze trim and flanged or threaded ends.

2.11.2.4   Butterfly Valves

Butterfly valves shall be in accordance with MSS SP-67, Type 1 and shall be 2 flange or lug wafer type, and shall be bubble tight at [150] [250] psig. Valve bodies shall be cast iron, malleable iron, or steel. Valves smaller than 8 inches shall have throttling handles with a minimum of seven locking positions. Valves 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

2.11.2.5   Plug Valves

Plug valves 2 inches and larger shall conform to MSS SP-78, have flanged or threaded ends, and have cast iron bodies with bronze trim. Valves 2 inches and smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valves shall be lubricated, non-lubricated, or tetrafluoroethylene resin-coated type. Valves shall be resilient, double seated, trunnion mounted with tapered lift plug capable of 2-way shutoff. Valves shall operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valves shall a weatherproof operators with mechanical position indicators. Valves 8 inches or larger shall be provided with manual gear operators with position indicators.

2.11.2.6   Ball Valves

Ball valves 1/2 inch and larger shall conform to MSS SP-72 or MSS SP-110 and shall be ductile iron or bronze with threaded, soldered, or flanged ends. Valves 8 inches or larger shall be provided with manual gear operators with position indicators.

2.11.2.7   Calibrated Balancing Valves

****

NOTE: Plug and ball valves defined above will be used as manual balancing valves and will be indicated on the drawings. A supplemental flow measuring scheme or device must be used to measure flow with a manual balancing valve. A calibrated balancing valve incorporates a flow measuring element and can be used in place of a manual balancing valve and a flow measuring device. Delete the last sentence of this paragraph if inapplicable.

****

Each valve shall be calibrated so that flow can be determined when the temperature and pressure differential across valve is known. Valves shall have an integral pointer which registers the degree of valve opening. Each valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation. Valves Cv rating shall be as indicated. Valve bodies shall be provided with tapped openings and pipe extensions with positive shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. One portable differential meter, suitable for the operating pressure specified, shall be provided. The meter shall be complete with hoses, vent, integral metering connections, and carrying case as recommended by the valve manufacturer. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing.

2.11.2.8   Automatic Flow Control Valves

****

NOTE: An automatic flow control valve offers

complete flow control in many applications; however, the flow control range is dependent on inlet pressure being within a given range, the flow selection is limited, and, in some cases it may require pump power slightly more than alternative balancing means. In any facility where typical load imbalances cannot be tolerated and where automatic control is needed to ensure constant hydronic flow, the design will incorporated automatic flow control valves. The location and capacity of the automatic control valves will be shown on the drawings.

****

Valves shall automatically maintain a constant flow as indicated. Valves shall modulate by sensing the pressure differential across the valve body. Valves shall be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Valves shall control the flow within 5 percent of the tag rating. Valve materials shall be the same as specified for the ball or plug valves. Valve Cv rating shall be as indicated. Valve operators shall be the [electric] [or] [pneumatic] type as indicated. Valves shall be capable of positive shutoff against the system pump head, valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings and differential meter, suitable for the operating pressure specified. The meter shall be complete with hoses, vent, integral metering connections, and carrying case as recommended by the valve manufacturer.

2.11.2.9 Air Vents

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NOTE: Air vents will be shown on drawings; distinguish between manual and automatic air vents.

****

Manual air vents shall be brass or bronze valves or cocks suitable for 125 psig service, and furnished with threaded plugs or caps. Automatic air vents shall be float type, cast iron, stainless steel, or forged steel construction, suitable for 125 psig service.

2.11.2.10 Strainers

****

NOTE: Reference ASTM F 1199 when the operating conditions are at 1034 kPa (150 psig) and 66 degrees C (150 degrees F) or less; otherwise reference ASTM F 1200.

****

Strainers shall be in accordance with [ASTM F 1199] [ASTM F 1200], except as modified herein. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. The strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with removable cover and sediment screen. The screen shall be made of minimum 22 gauge [brass sheet,] [monel,] [corrosion-resistant steel,] with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.11.2.11 Combination Strainer and Suction Diffuser

A combination strainer and suction diffuser, consisting of an angle type body with removable strainer basket and straightening vanes, a suction pipe support, and a blowdown outlet, shall be provided on pump suction. The combination strainer and suction diffuser shall be in accordance with [ASTM F 1199] [ASTM F 1200], except as modified herein.

2.11.2.12 Pump Discharge Valves

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NOTE: Pump discharge valves can be used as an alternative to a gate valve, a check valve, and a balancing valve on the discharge side of a pump.

****

Pump discharge valves shall be installed where indicated and shall perform the functions of a nonslam check valve, a manual balancing valve, and a shutoff. Valves shall be of cast iron or ductile iron construction with bronze and/or stainless steel accessories. Valves shall have an integral pointer which registers the degree of valve opening. Flow through the valve shall be manually adjustable from bubble tight shutoff to full flow. Valves smaller than 2 inches shall have NPT connections. Valves 2 inches and larger shall have flanged or grooved end connections. The valve design shall allow the back seat for the stem to be replaced in the field under full line pressure. Valve Cv rating shall be as indicated.

2.11.2.13 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 125 psig or 150 psig service as appropriate for the static head plus the system head, and [250] [230] degrees F, for grooved end flexible connectors. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. The flexible section shall be suitable for intended service with end connections to match adjacent piping. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

2.11.2.14 Pressure Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 3-1/2 inches in diameter with a range from 0 psig to approximately 1.5 times the maximum system working pressure.

2.11.2.15 Thermometers

Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 9 inch scale. Thermometers shall have rigid stems with straight, angular, or inclined pattern.

2.11.2.16 Pipe Nipples

Pipe nipples shall be in accordance with ASTM A 733 and be of material to match adjacent piping.

2.11.2.17 Pipe Unions

Pipe unions shall be in accordance with ASME B16.39 and be of material to match adjacent piping.

2.11.2.18 Solder

Solder for water piping shall be in accordance with ASTM B 32, alloy grade 50B. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B 813.

2.11.3 Expansion Joints

****

NOTE: Expansion loops, offsets, and bends will be used where possible instead of expansion joints. All expansion provisions, including necessary details, will be shown on the drawings. Expansion joints should be located in serviceable areas. Expansion joints may only be installed on water piping.

****

2.11.3.1 Slip-Tube Joints

Expansion joints shall provide for either single or double slip of the connected pipes, as required or indicated, and for not less than the traverse indicated. The joints shall be designed for working temperature and pressure suitable for the application, but not less than 150 psig, and shall be in accordance with applicable requirements of EJMA Stds and ASME B31.1. End connections shall be flanged or beveled for welding as indicated. Joints shall be provided with an anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip shall be seamless steel plated with a minimum of 5 mils of hard chrome in accordance with ASTM B 650. All joint components shall be suitable for the intended service. Initial settings shall be made in accordance with the manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer. Pipe alignment guides shall in no case be more than 5 feet from expansion joints except for pipe 4 inches or smaller. Pipe alignment guides on pipe 4 inches or smaller shall be installed not more than 2 feet from expansion joints. Service outlets shall be provided where indicated.

2.11.3.2 Flexible Ball Joints

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NOTE: The ball joint only moves in an angular offset or rotation mode. The configuration of the

ball joint link will require a 2 or 3 ball joint offset to absorb axial and/or lateral movement.
****

Flexible ball joints shall be constructed of alloys as appropriate for the service intended. Where so indicated, the ball joint shall be designed for packing injection under full line pressure to contain leakage. The joint ends shall be threaded to 2 inches only, grooved, flanged, or beveled for welding as indicated or required and shall be capable of absorbing a minimum of 15 degree angular flex and 360 degree rotation. Ball and sockets shall be suitable for the intended service. The exterior spherical surface of carbon steel balls shall be plated with minimum 5 mils of hard chrome in accordance with EJMA Stds and ASME B31.1 where applicable. Where required, flanges shall conform to ASME B16.5.

2.11.3.3 Bellows Type Joints

Bellows type joints shall be flexible, guided expansion joints. The expansion element shall be stabilized corrosion resistant steel. Bellows type expansion joints shall conform to the applicable requirements of EJMA Stds and ASME B31.1 with internal sleeves. Guiding of piping on both sides of expansion joint shall be in accordance with the published recommendations of the manufacturer of the expansion joint. The joints shall be designed for the working temperature and pressure suitable for the application but not less than 150 psig.

2.11.4 Refrigerant Piping and Fittings

Refrigerant piping, valves, fittings, and accessories shall conform to the requirements of ASHRAE 15 and ASME B31.5, except as specified.

2.11.4.1 Steel Pipe

Steel pipe for refrigerant service shall conform to ASTM A 53, Schedule 40, Type E or S, Grades A or B. Type F pipe shall not be used.

2.11.4.2 Steel Pipe Joints and Fittings

Joints and fittings shall be steel butt-welding, socket-welding, or malleable iron threaded type. Pipe shall be welded except that joints on lines 2 inches and smaller may be threaded. Threads shall be tapered type conforming to ASME B1.20.1. The malleable iron threaded type fitting shall be of a weight corresponding to adjacent pipe. Flanges and flange faces of fittings shall be tongue-and-groove type with gaskets suitable for the refrigerant used; size 1 inch and smaller shall be oval, two-bolt type; size above 1 inch, up to and including 4 inches, shall be square four-bolt type; and sizes over 4 inches shall be round.

2.11.4.3 Steel Tubing

Steel tubing for refrigeration service shall be in accordance with ASTM A 334/A 334M, Grade 1. Tubing with a nominal diameter of 3/8 inch or 1/2 inch shall have a wall thickness of 0.049 inches. Tubing with a nominal diameter of 3/4 inch through 2 inches shall have a wall thickness of 0.065 inches. Tubing with a nominal diameter of 2-1/2 inches through 4 inches shall have a wall thickness of 0.095 inches. Steel tubing shall be cold-rolled, electric-forged, welded-steel. One end of the tubing shall be provided with a socket. Steel tubing shall be cleaned, dehydrated, and capped.

2.11.4.4   Steel Tubing Joints and Fittings

Joints and fittings shall be socket type provided by the steel tubing manufacturer.

2.11.4.5   Copper Tubing

Copper tubing shall conform to ASTM B 280 annealed or hard drawn as required. Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing shall not be used in sizes larger than 1-3/8 inches. Joints shall be brazed except that joints on lines 7/8 inchand smaller may be flared.

2.11.4.6   Copper Tube Joints and Fittings

Copper tube joints and fittings shall be flare joint type with short-shank flare, or solder-joint pressure type. Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings shall not be allowed for brazed joints.

2.11.5   Refrigerant Piping, Valves, and Accessories

Valves shall be pressure and temperature rates for contained refrigerant service and shall comply with ASME B31.5. Metals of constructions shall be ferrous or copper based. Atmosphere exposed valve stems shall be stainless steel or corrosion resistant metal plated carbon steel. Valve body connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Valves shall be suitable for or fitted with extended copper ends for brazing in-place without disassembly. Ferrous body valves shall be fitted with factory fabricated and brazed copper transitions. To minimize system pressure drops, where practicable, globe valves shall be angle body type, and straight line valves shall be full port ball type. Control valve inlets shall be fitted with integral or adapted strainer or filter where recommended or required by the manufacturer. Valves shall be cleaned and sealed moisture-tight.

2.11.5.1   Refrigerant-Stop Valves

Valves, in sizes through 5/8 inch, shall be handwheel operated, straight or angle, packless diaphragm globe type with back-seating stem, brazed ends, except where SAE flare or retained seal cap connections are required. In sizes over 5/8 inch, valves shall be globe or angle type, wrench operated with ground-finish stems, or ball valves, packed especially for refrigerant service, back seated, and provided with seal caps. Refrigerant isolation and shut-off valves shall have retained or captive spindles and facilities for tightening or replacement of the gland packing under line pressure as applicable. Stop valves hall have back-seating plated steel stem, bolted bonnet in sizes 1-1/8 inches OD and larger, integral or flanged transition brazed socket. Valves in sizes through 2-1/2 inches shall be end-entry body assembly, full-port, floating ball type, with equalizing orifice fitted chrome plated ball, seats and seals of tetrafluoroethylene, chrome plated or stainless steel stem, and seal cap. In sizes 4 inch IPS and larger, and in smaller sizes where carbon steel piping is used, valve bodies shall be tongue and groove flanged and complete with mating flange, gaskets and bolting for socket or butt-welded connection. Purge, charge and receiver valves shall be of manufacturer's standard configuration.

2.11.5.2   Check Valves

Valve shall be designed for service application, spring-loaded type where required, with resilient seat and with flanged body in sizes 1/2 inch and larger. Valve shall provide positive shutoff at [1-1/2] [2] [3] psi differential pressure.

2.11.5.3   Liquid Solenoid Valves

Valves shall comply with ARI 760 and be suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves shall be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions shall be furnished. Solenoid coils shall be moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves shall have safe working pressure of 400 psi and a maximum operating pressure differential of at least 200 psi at 85 percent rated voltage. Valves shall have an operating pressure differential suitable for the refrigerant used.

2.11.5.4   Expansion Valves

Expansion valves shall conform to requirements of ARI 750. Valve shall be of the diaphragm and spring type with internal or external equalizers, and bulb and capillary tubing. Valve shall be provided with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 2 degrees F of saturated suction temperature at evaporator conditions. Bulb charge shall be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Gas limited liquid charged valves and other valve devices for limiting evaporator pressure shall not be used without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves shall have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. An isolatable pressure gauge shall be provided in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicted or for constant evaporator loads.

2.11.5.5   Safety Relief Valves

Valve shall be two-way type. Single type valves shall be used only where indicated. Valve shall bear the ASME code symbol. Valve capacity shall be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve shall be of an automatically reseating design after activation.

2.11.5.6   Evaporator Pressure Regulators, Direct-Acting

Valve shall include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve shall maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load shall not exceed the pressure difference corresponding to a 2 degrees F change in saturated refrigerant temperature at evaporator operating suction temperature. Spring shall be selected for indicated maximum allowable suction pressure range.

2.11.5.7 Refrigerant Access Valves

Refrigerant access valves and hose connections shall be in accordance with ARI 720.

2.11.5.8 Filter Driers

Driers shall conform to ARI 710. Sizes 5/8 inch and larger shall be the full flow, replaceable core type. Sizes 1/2 inch and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 1,500 psi.

2.11.5.9 Sight Glass and Liquid Level Indicator

a. Assembly and Components: Assembly shall be pressure- and temperature-rated and constructed of materials suitable for the service. Glass shall be borosilicate type. Ferrous components subject to condensation shall be electro-galvanized.

b. Gauge Glass: Gauge glass shall include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

c. Bull's-Eye and Inline Sight Glass Reflex Lens: Bull's-eye and inline sight glass reflex lens shall be provided for dead-end liquid service. For pipe line mounting, two plain lenses in one body suitable for backlighted viewing shall be provided.

d. Moisture Indicator: Indicator shall be a self-reversible action, moisture reactive, color changing media. Indicator shall be furnished with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator shall be an integral part of each corresponding sight glass.

2.11.5.10 Vibration Dampeners

Dampeners shall be of the all-metallic bellows and woven-wire type.

2.11.5.11 Flexible Pipe Connectors

Connector shall be pressure and temperature rated for the service in accordance with ASHRAE 15 and ASME B31.5. Connector shall be a composite of interior corrugated phosphor bronze or Type 300 Series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Assembly shall be constructed with a safety factor of not less than 4 at 300 degrees F. Unless otherwise indicated, the length of a flexible connector shall be as recommended by the manufacturer for the service intended.

2.11.5.12 Strainers

Strainers used in refrigerant service shall have brass or cast iron body, Y-or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe diameter with pressure rating compatible with the refrigerant service. Screens shall be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

2.11.5.13 Brazing Materials

Brazing materials for refrigerant piping shall be in accordance with AWS A5.8, Classification BCuP-5.

2.11.6 Escutcheons

Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

2.11.7 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.12 FABRICATION

2.12.1 Factory Coating

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NOTE: Adequate protection will be specified and unit will be tested in a salt spray fog test. A 125 hour test will be specified in a noncorrosive environment and a 500 hour test will be specified in a corrosive environment.

****

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 500 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

2.12.2 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09900 PAINTING, GENERAL.

2.12.2.1 Color Coding

****

NOTE: Color coding for piping identification required by the using agency will be developed and

inserted in the "Color Code Schedule" in Section 09900 PAINTING, GENERAL. For Air Force Installations, piping will be color-coded in accordance with Attachment 4 of AFM 88-15.
****

Color coding for piping identification is specified in Section 09900 PAINTING, GENERAL.

2.12.2.2 Color Coding Scheme

****
NOTE: Color Coding Scheme may be deleted in accordance with Notes in Section 15400 PLUMBING, GENERAL PURPOSE.
****

A color coding scheme for locating hidden piping shall be in accordance with [Section 15400 PLUMBING, GENERAL PURPOSE] [Section 15405 PLUMBING, HOSPITAL].

2.13 FACTORY TESTS

2.13.1 Chiller Performance Test

****
NOTE: In order to ensure that liquid chillers meet the capacity and efficiencies specified, factory testing will be specified on all units between 1054 and 5622 kW (300 and 1600 tons). Tests may be specified for smaller chillers in critical applications where the tests are felt justified. The ARI testing of chillers allows a deviation to chiller capacity of up to 5% at full load. Load calculations should consider this tolerance.
****

The Contractor and proposed chiller manufacturer shall be responsible for performing the chiller factory test to validate the specified full load capacity, full load EER, and [IPLV] [APLV] in accordance with ARI 550 except as indicated. [The chiller factory test shall be performed in the presence of a Government representative.] The Contractor and chiller manufacturer shall provide to the Government a certified chiller factory test report in accordance with ARI 550 to confirm that the chiller performs as specified. All tests shall be conducted in an ARI certified test facility in conformance with ARI 550 procedures and tolerances, except as indicated. At a minimum, chiller capacity shall be validated to meet the scheduled requirements indicated on the drawings. Tolerance or deviation shall be in strict accordance with ARI 550.Stable operation at minimum load of 10 percent of total capacity shall be demonstrated during the factory test.

a. Temperature adjustments shall adhere to ARI 550 to adjust from the design fouling factor to the clean tube condition. Test temperature adjustments shall be verified prior to testing by the manufacturer. There shall be no exceptions to conducting the test with clean tubes with the temperature adjustments per section A7.3

of ARI 550. The manufacturer shall clean the tubes, if necessary, prior to testing to obtain a test fouling factor of 0.0000.

b. The factory test instrumentation shall be per ARI 550 and the calibration shall be traceable to the National Institute of Standards and Technology.

c. A certified test report of all data shall be forwarded to the Government for approval prior to project acceptance. All calibration curves and information sheets for all instrumentation shall be provided.

d. If the equipment fails to perform within allowable tolerances, the manufacturer shall be allowed to make necessary revisions to his equipment and retest as required. [The manufacturer shall assume all expenses incurred by the Government to witness the retest.]

2.13.2 Chiller Sound Test

****
NOTE: Include factory sound test requirements in applications where chiller sound level is a critical requirement. Select 85 decibels if military personnel (90 decibels for civilian personnel) will operate the equipment without hearing protection. Other decibel requirements may be specified if hearing protection is provided.
****

All centrifugal chillers shall be sound tested at the factory prior to shipment to confirm the sound pressure level specified below. All tests and data shall be conducted and measured in strict accordance with ARI 575. The centrifugal chiller sound pressure level, in decibels (dB), with a reference pressure of 20 micropascals, shall not exceed [85] [90] [_____] dB, A weighted, at full load. All ratings shall be in accordance with ARI 575. No reduction of entering condenser water temperature or raising of leaving chilled water temperature shall be allowed. A minimum of 75 percent of the sound data points shall be taken along the length of the machine, and established as the minimum percentage of total possible points used to determine sound levels. In the event that the chiller does not meet the dBA sound pressure level, the manufacturer shall, at his expense, provide sufficient attenuation to the machine to meet the specified value. This attenuation shall be applied in such a manner that it does not hinder the operation or routine maintenance procedures of the chiller. The attenuation material, adhesives, coatings, and other accessories shall have surface burning characteristics as determined by ASTM E 84.

2.14 SUPPLEMENTAL COMPONENTS/SERVICES

2.14.1 Drain and Makeup Water Piping

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NOTE: All drain and makeup water piping should be indicated on the drawings.
****

Piping and backflow preventers shall comply with the requirements of Section 15400 PLUMBING, GENERAL PURPOSE. Drains which connect to sanitary sewer system shall be connected by means of an indirect waste.

2.14.2 Steam Piping and Accessories

Steam piping and accessories shall be provided and installed in accordance with Section 15569 WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH.

PART 3 EXECUTION

3.1 INSTALLATION

All work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPV VIII Div 1 and ASME BPV IX, the design, fabrication, and installation of the system shall conform to ASME BPV VIII Div 1 and ASME BPV IX.

3.1.1 Refrigeration System

3.1.1.1 Equipment

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NOTE: Designer will determine in the initial stages of design the approximate distances required for maintenance clearances of all new equipment. The maintenance clearances will be used in determining the final layout of the equipment.

For installations where noise and vibration transmission to the building must be reduced, the maximum tolerable transmissibility, in percent, should be determined and the blank filled in with the appropriate value. When it is not necessary to specify the percent of transmissibility, the item in the brackets will be deleted and brackets removed. Recommended transmissibility in percentages are: 10 percent for equipment mounted in very critical areas; 10 to 20 percent for critical areas; and 20 to 40 percent for noncritical areas. The drawings should be checked to ensure that all structural and equipment connection factors and the conditions surrounding the equipment to be provided with the vibration isolation units favorably influence the effectiveness of the isolators. Where many items of equipment require different transmission values, based on the equipment location, the specification may be revised to indicate the appropriate values on the drawings.

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Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, liquid coolers, and similar items. Compressors shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be provided. Each foundation shall include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment shall be set on not less than a 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps shall have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block shall be of mass not less than three times the combined pump, motor, and base weights. Isolators shall be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators shall limit vibration to [_____] percent at lowest equipment rpm. Lines connected to pumps mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations and concrete-structured or cased-cooling towers shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.1.1.2 Refrigerant Charging

a. Initial Charge: Upon completion of all the refrigerant pipe tests, the vacuum on the system shall be broken by adding the required charge of dry refrigerant for which the system is designed, in accordance with the manufacturer's recommendations. Contractor shall provide the complete charge of refrigerant in accordance with manufacturer's recommendations. Upon satisfactory completion of the system performance tests, any refrigerant that has been lost from the system shall be replaced. After the system is fully operational, service valve seal caps and blanks over gauge points shall be installed and tightened.

b. Refrigerant Leakage: If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant shall be pumped into the system receiver or other suitable container. The refrigerant shall not be discharged into the atmosphere.

c. Contractor's Responsibility: The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 oz. of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the specified requirements including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.1.1.3 Oil Charging

Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase shall be furnished. One charge shall be used during the performance testing period, and upon the satisfactory completion of the tests, the oil shall be drained and replaced with the second charge.

3.1.1.4 Automatic Controls

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NOTE: Change paragraph as required to coordinate the central equipment controls with the air-side system controls. In projects where this section of the specifications is intended to produce control equipment for existing air-side systems, this paragraph will be rewritten to secure controls to match existing controls and to properly integrate the specified controls into the existing temperature control system. Designer will be required to put a sequence of control for each cooling tower fan, chilled water pump, condenser water pump, etc. on the contract drawings.

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Automatic controls for the central refrigeration system specified in paragraph REFRIGERATION SYSTEM shall be provided with the central refrigeration equipment. These controls shall operate automatically to balance the equipment capacity with the load on the air conditioning system, and shall be fully coordinated with and integrated [into the temperature control system specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM and 15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS] [into the existing air-conditioning system].

3.1.2 General Piping Installation

3.1.2.1 Brazed Joints

Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Joints in steel tubing shall be painted with the same material as the baked-on coating within 8 hours after joints are made. Tubing shall be protected against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. All piping shall be supported prior to brazing and shall not be sprung or forced.

3.1.2.2 Threaded Joints

Threaded joints shall be made with tapered threads and made tight with PTFE tape complying with ASTM D 3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

3.1.2.3 Welded Joints

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NOTE: The first set of brackets shall be deleted when more stringent requirements for weldments exist, otherwise delete the third set. Retain the second set only when required for structural members.

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[Welding shall be in accordance with qualified procedures using qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Contracting Officer shall be notified 24 hours in advance of welding tests and the tests shall be performed at the work site if practical. A permanent mark shall be applied near each weld to identify the welder who made that weld.] [Structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL.] [Welding and nondestructive testing procedures are specified in Section 05093 WELDING PRESSURE PIPING.] Welded joints in steel refrigerant piping shall be fusion-welded. Changes in direction of piping shall be made with welded fittings only; mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. Branch connections shall be made with welding tees or forged welding branch outlets. Steel pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1 or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.2.4 Flanged Joints

Flanged joints shall be faced true, provided with gaskets suitable for use with refrigerants and made square and tight. When steel refrigerant piping is used, union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment requiring maintenance, such as compressors, coils, chillers, control valves, and other similar items.

3.1.2.5 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.2.6 Thermometers

Thermometers shall be located specifically on, but not limited to the following: [condenser water lines entering and leaving the condenser] [the sensing element of each automatic temperature control device where a thermometer is not an integral part thereof] [the liquid line leaving receiver] [and] [the suction line at each evaporator or liquid cooler].

3.1.2.7 Supports

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NOTE: Provide seismic details, if a Government designer (either Corps office of A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase in item b. if no seismic details are provided. Sections 13080 and 15070, properly edited, must be included in the contract documents.

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a. General: All refrigerant pipe supports shall be in accordance with ASME B31.5. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

b. Seismic Requirements: All piping and attached valves shall be supported and braced to resist seismic loads as specified under Sections 13080 SEISMIC PROTECTION FOR MILCELLANEOUS EQUIPMENT and 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT [as shown on the drawings]. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05120 STRUCTURAL STEEL.

c. Structural Attachments: Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material and installation shall be as specified under Section 05120 STRUCTURAL STEEL.

3.1.2.8 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used.

a. Hangers: Type 3 shall not be used on insulated piping.

b. Inserts: Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

c. C-Clamps: Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

d. Angle Attachments: Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

e. Hangers: Type 24 may be used only on trapeze hanger systems or on fabricated frames.

f. Saddles and Shields: Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

g. Horizontal Pipe Supports: Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. [Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.]

h. Vertical Pipe Supports: Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

i. Pipe Guides: Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

j. Steel Slides: Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle shall be used. On piping under 4 inches,a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

k. High Temperature Guides with Cradles: Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.

l. Multiple Pipe Runs: In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.2.9 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.1.2.10 Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Detailed drawings of pipe anchors shall be submitted for approval before installation.

3.1.2.11 Pipe Sleeves

Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Unless otherwise indicated, sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe or cast iron pipe. Sleeves in non-bearing walls, floors, or ceilings may be steel pipe, cast iron pipe, galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated, or moisture resistant fiber or plastic. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed as indicated and specified in Section 07900 JOINT SEALING. Pipes passing through wall waterproofing membrane shall be sleeved as specified above, and a waterproofing clamping flange shall be installed.

a. Roof and Floor Penetrations: Pipes passing through roof or floor waterproofing membrane shall be installed through a 17 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2 inches above highest floor level of the roof or a minimum of 10 inches above the roof, whichever is greater, or 10 inches above the floor. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess. In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

b. Fire-Rated Walls and Partitions: Penetration of fire-rated walls and partitions shall be sealed as specified in Section 07840 FIRESTOPPING.

3.1.2.12 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

3.1.2.13 Access Panels

Access panels shall be provided for all concealed valves, vents, controls, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METALS.

3.1.3 Water Piping

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

3.1.3.1 Directional Changes

Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

3.1.3.2 Functional Requirements

Horizontal supply mains shall pitch down in the direction of flow as indicated. The grade shall not be less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the system. Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 2-1/2 inches or less in diameter, and with flanges for pipe 3 inches and above in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric unions or flanges. All piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded.

3.1.3.3 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

3.1.3.4 Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

3.1.3.5 Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.3.6 Flexible Pipe Connectors

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NOTE: Flexible pipe connectors will be provided where required to absorb expansion and contraction, isolate vibration, absorb noise, compensate offset motion, absorb continuous flexing, and relieve equipment from piping stresses. Where flexible pipe connectors are needed to correct lateral, parallel, and angular misalignment, their use will be limited to maximum offset as recommended, in writing, by the manufacturer. Flexible pipe connectors will only be used on water piping.

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Preinsulated flexible pipe connectors shall be attached to other components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the flexible pipe connector manufacturer and shall be provided at the intervals recommended.

3.1.3.7 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

3.1.3.8 Grooved Mechanical Joints

Grooves shall be prepared in accordance with the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances.

3.1.4 Refrigeration Piping

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NOTE: Belowground refrigerant piping should be avoided if at all possible. Direct buried refrigerant piping will not be installed under any circumstances. In the event that belowground pipe routing is the only alternative, the piping will be routed through an accessible trench system (i.e. concrete, fiberglass, PVC, etc). The designer will specifically detail the trench design as well as fully detail the piping techniques necessary to accommodate oil circulation at both full and part load conditions. Oil circulation is extremely critical to the successful operation of any refrigerant system. Designers will avoid creating any oil traps within a refrigerant piping system.

****

Unless otherwise specified, pipe and fittings installation shall conform to requirements of ASME B31.5. Pipe shall be cut accurately to measurement established at the jobsite and worked into place without springing or forcing. Cutting or otherwise weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipes shall be cut square, shall have burrs removed by reaming, and shall be installed in a manner to permit free expansion and contraction without damage to joints or hangers. Filings, dust, or dirt shall be wiped from interior of pipe before connections are made.

3.1.4.1 Directional Changes

Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide-sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, or other malformations will not be accepted.

3.1.4.2 Functional Requirements

All piping shall be installed 1/2 inch per 10 feet of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings.

3.1.4.3 Valves

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NOTE: Delete last two sentences when identification tags are not considered necessary in small projects.

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a. Stop valves shall be installed on each side of each piece of equipment such as compressors condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Angle and globe valves shall be installed with stems horizontal unless otherwise indicated. Ball valves shall be installed with stems positioned to facilitate operation and maintenance. All valves except check valves shall be identified with a brass or aluminum tag not less than 1-3/8 inch in diameter, correctly stamped to explain the valve function, and with a number for identification. Tags shall be secured to the valve with No. 12 AWG copper wire.

b. Expansion valves shall be installed with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 2-1/8 inches in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 2-1/8 inches. The bulb shall be securely fastened with two clamps. The bulb shall be insulated. The bulb shall installed in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing shall be facing up.

3.1.4.4 Vibration Dampers

Vibration damper shall be provided in the suction and discharge lines on spring mounted compressors. Vibration dampers shall be installed parallel with the shaft of the compressor and shall be anchored firmly at the upstream end on the suction line and the downstream end in the discharge line.

3.1.4.5 Strainers

Strainers shall be provided immediately ahead of all solenoid valves and expansion devices. Strainers may be an integral part of the expansion valve.

3.1.4.6 Filter Dryer

A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. The filter dryer shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed. The filter dryer shall be installed such that the filter dryer can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Filter dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

3.1.4.7 Sight Glass

A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers.

3.1.4.8 Discharge Line Oil Separator

Discharge line oil separator shall be provided in the discharge line from each compressor. Oil return line shall be connected to the compressor as recommended by the compressor manufacturer.

3.1.4.9 Accumulator

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NOTE: Suction line accumulator should be included under certain split system applications, such as having extended refrigerant lines, 15 m (50 feet) or longer. If accumulator is not used then delete this paragraph.

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Accumulators shall be provided in the suction line to each compressor.

3.1.5 Mechanical Room Ventilation

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For mechanical rooms which are intended to house refrigeration equipment, designers will use ASHRAE 15 to determine applicable design criteria. Delete this paragraph if a mechanical room is not applicable to the design.

In summary, ASHRAE 15 allows the use of either natural or mechanical ventilation systems, however natural ventilation is allowed only in certain limited applications. Natural ventilation is allowed only when "a refrigerant system is located outdoors more than 20 feet from building openings and is enclosed by a penthouse, lean-to or other open structure", otherwise mechanical ventilation is required.

The amount of ventilation air required for a mechanical room will be determined based upon the ventilation equations in ASHRAE 15. In order to use these equations, a designer must approximate the mass of refrigerant or lbs expected in the largest system located in the mechanical room. Refrigerant quantities will be determined based upon a minimum of 2 different system manufacturers.

a. For a natural ventilation system, ASHRAE 15 provides an equation for sizing the amount of free opening area required.

b. For a mechanical ventilation system, ASHRAE 15 requires both normal and alarm ventilation. Normal ventilation will be sized to cover personnel ventilation requirements or 0.5 cfm/ft2 and heat buildup requirements if applicable. Alarm ventilation will be sized based upon the equations in ASHRAE 15. Both the normal and alarm ventilation rates can be achieved using the same ventilation system (e.g., multi-speed exhaust fans), however, individual systems are preferred. For the alarm

ventilation, exhaust intakes will be located near the equipment and close to the finished floor. Most commonly used refrigerants are heavier-than-air and subsequently sink to the floor. Also per ASHRAE 15, air supply and exhaust ducts to the mechanical room will serve no other area within a facility. Discharge air from a mechanical ventilation system will be to the outdoors.

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Mechanical ventilation systems shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

3.1.6 Field Applied Insulation

Field applied insulation other than that specified for water boxes and headers shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.7 Factory Applied Insulation

3.1.7.1 Refrigerant Suction Lines

[Refrigerant suction lines between the cooler and each compressor [and cold gas inlet connections to gas cooled motors]] [Refrigerant pumps and exposed chilled water lines on absorption chillers] shall be insulated with not less than 3/4 inch thick unicellular plastic foam.

3.1.7.2 Liquid Coolers

Liquid coolers (including chilled water headers or boxes), which may have factory or field applied insulation, shall be insulated with unicellular plastic foam. Insulation shall be not less than 3/4 inch thick or have a maximum thermal conductivity of 0.28 Btu/(hr.)(sq. ft.)(degree F.))). In lieu of the above insulation, a 2 inch thickness of urethane foam may be used. Urethane foam shall be completely covered and sealed with a sheet metal jacket not lighter than 20 gauge. Insulation on heads of coolers shall be constructed to provide easy removal and replacement of heads without damage to the insulation.

3.2 TESTS

3.2.1 Field Tests

Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. The services of a qualified technician shall be provided as required to perform all tests and procedures indicated herein. Field tests shall be coordinated with Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.2.1.1 Water Pipe Testing

After cleaning, water piping shall be hydrostatically tested at a pressure equal to 150 percent of the total system operating pressure for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Leaks shall be repaired and piping retested until test is successful. No loss of pressure shall be allowed. Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before concealing.

3.2.1.2 Test of Backflow Prevention Assemblies

Backflow prevention assemblies shall be tested in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

3.2.1.3 Refrigerant Pipe Testing

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NOTE: Where applicable condensing temperature is over 54 degrees C (130 degrees F), equipment and piping will be capable of withstanding leak pressure tests at not less than the design pressure corresponding to the condensing pressure during the higher ambient conditions. (Refer to ASHRAE 15.)

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a. Refrigerant Leakage Test: After all components of the refrigerant system have been installed and the piping connected, the system shall be subjected to a refrigerant leakage test. The refrigerant leakage test shall be done with dry nitrogen before any refrigerant pipe is insulated or covered. High and low side of the refrigerant system shall be tested for the minimum refrigerant leakage test pressure specified in ASHRAE 15, for the refrigerant employed in the system. System shall be proved tight and free of leaks by allowing the refrigerant leakage test pressure to remain on the system for 24 hours with no drop in pressure. The initial test pressure and surrounding air temperature will be recorded. After the 24 hour hold period, the final system pressure and surrounding air temperature will be recorded. A correction of 0.3 psi shall be allowed for each degree F change in the initial and final temperature of the surrounding air, plus for an increase and minus for a decrease. The system shall have passed the refrigerant leakage test if the corrected final system pressure is equal to the initial system test pressure. If the pressures are not equal, the leaks shall be located and repaired.

b. Refrigerant Leaks: To repair leaks, the joint shall be taken apart, thoroughly cleaned, and remade as a new joint. Joints repaired by caulking or remelting and adding more brazing material will not be acceptable. After leak repairs have been made, the refrigerant leakage test shall be conducted again.

c. Evacuation Test: After the foregoing tests have been satisfactorily completed and the pressure relieved, entire system shall be evacuated to an absolute pressure of 300 microns. During evacuation of the system, the ambient temperature shall be higher than 35 degrees F. Vacuum line shall be closed, and the system shall stand for 1 hour. After this period, the absolute pressure shall not exceed 500 microns. If the pressure rises over 500 microns, the system shall continue to be evacuated until the system reaches 300 microns and can stand for 1 hour with the vacuum line closed without the absolute pressure rising over 500 microns. During evacuation, pressures shall be recorded by a thermocouple type, electronic type, or a calibrated-micron type gauge.

3.2.1.4 Cooling Tower Tests

After cooling tower has been found acceptable under the visual and dimensional examination, a field performance test shall be performed in accordance with ASME PTC 23 or CTI ATC-105. The [electromagnetic interference suppression test] [and the] [salt spray test is not required]. The cooling tower test shall be performed in the presence of a Government representative.

3.2.2 System Performance Tests

After the foregoing tests have been completed and before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment shall be conducted by a registered professional engineer or an approved manufacturer's startup representative experienced in system startup and testing, at such times as directed. Tests shall cover a period of not less than [_____] days for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be re-conducted to demonstrate that the entire system is functioning as specified.

3.2.3 Condenser Water Quality Tests

The condenser water shall be analyzed a minimum of once a month for a period of one year by the water treatment company. The analysis shall include the following information recorded in accordance with ASTM D 596.

Date of Sample	_____
Temperature	_____ degrees F.
Silica (SiO2)	_____ ppm (mg/1)
Insoluble	_____ ppm (mg/1)
Iron and Aluminum Oxides	_____ ppm (mg/1)
Calcium (Ca)	_____ ppm (mg/1)
Magnesium (Mg)	_____ ppm (mg/1)
Sodium and Potassium (Na and K)	_____ ppm (mg/1)
Carbonate (HCO3)	_____ ppm (mg/1)
Sulfate (SO4)	_____ ppm (mg/1)
Chloride (Cl)	_____ ppm (mg/1)
Nitrate (NO3)	_____ ppm (mg/1)
Turbidity	_____ unit
pH	_____
Residual Chlorine	_____ ppm (mg/1)
Total Alkalinity	_____ epm (meq/1)
Non-Carbonate Hardness	_____ epm (meq/1)
Total Hardness	_____ epm (meq/1)
Dissolved Solids	_____ ppm (mg/1)
Fluorine	_____ ppm (mg/1)
Conductivity	_____ micrmho/cm

3.3 INSPECTIONS

At the conclusion of the one year period, the cooling tower and condenser shall be inspected for problems due to corrosion, scale, and biological growth. If the cooling tower and condenser are found not to conform to the manufacturers recommended conditions, and the water treatment company recommendations have been followed; the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

3.4 MANUFACTURER'S FIELD SERVICE

The services of a factory-trained representative shall be provided for [_____] days. The representative shall advise on the following:

a. Hermetic machines:

(1) Testing hermetic water-chilling unit under pressure for refrigerant leaks; evacuation and dehydration of machine to an absolute pressure of not over 300 microns.

(2) Charging the machine with refrigerant.

(3) Starting the machine.

b. Open Machines:

(1) Erection, alignment, testing, and dehydrating.

(2) Charging the machine with refrigerant.

(3) Starting the machine.

c. Absorption Units:

(1) Testing and evacuation.

(2) Charging the machine with refrigerant.

(3) Starting the machine.

3.5 CLEANING AND ADJUSTING

3.5.1 Piping

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented.

3.5.2 Equipment

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.6 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total [_____] hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

-- End of Section --

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09/93

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SECTION 15653

AIR-CONDITIONING SYSTEM (UNITARY TYPE)
09/93

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NOTE: This guide specification covers the requirements for single- and multi-zone air-conditioners, water-to-air and air-to-air heat pumps, condenser, humidifiers and cooling towers. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for room unit, package systems, split system, and AC for EDP. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 210/240	(1994) Unitary Air-Conditioning and Air-Source Heat Pump Equipment
ARI 270	(1995) Sound Rating of Outdoor Unitary Equipment
ARI 310/380	(1993) Packaged Terminal Air-Conditioners and Heat Pumps
ARI ANSI/ARI 320	(1993) Water-Source Heat Pumps
ARI 325	(1993) Ground Water-Source Heat Pumps
ARI 340/360	(1993) Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
ARI 350	(1986) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
ARI 370	(1986) Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
ARI 410	(1991) Forced-Circulation Air-Cooling and Air-Heating Coils
ARI 460	(1994) Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ARI 490	(1989) Remote Mechanical-Draft Evaporative Refrigerant Condensers
ARI 495	(1993) Refrigerant Liquid Receivers
ARI 500	(1990) Variable Capacity Positive Displacement Refrigerant Compressors and Compressor Units for Air-Conditioning and Heat Pump Applications
ARI 700	(1995; Apx C) Specifications for Fluorocarbon and Other Refrigerants
ARI 710	(1995) Liquid-Line Driers
ARI 720	(1997) Refrigerant Access Valves and Hose

	Connectors
ARI 750	(1994) Thermostatic Refrigerant Expansion Valves
ARI 760	(1994) Solenoid Valves for Use with Volatile Refrigerants

AIR DIFFUSION COUNCIL (ADC)

ADC 1062:GRD	(1984) Test Codes for Grilles, Registers and Diffusers

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA Std 500	(1989; Rev 1994) Test Methods for Louvers, Dampers and Shutters

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A13.1	(1996) Scheme for the Identification of Piping Systems
ANSI S1.13	(1995) Methods for the Measurement of Sound Pressure Levels

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990; R 1995) Ferritic Malleable Iron Castings
ASTM A 47M	(1990; R 1996) Ferritic Malleable Iron Castings (Metric)
ASTM A 48	(1994a) Gray Iron Castings
ASTM A 48M	(1994a) Gray Iron Castings (Metric)
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 106	(1997a) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 181/A 181M	(1995b) Carbon Steel Forgings, for General-Purpose Piping
ASTM A 183	(1983; R 1990) Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	(1998) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

ASTM A 234/A 234M	(1997) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A 307	(1997) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 334/A 334M	(1996) Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 653/A 653M	(1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B 32	(1996) Solder Metal
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1997) Seamless Copper Tube
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 88M	(1996) Seamless Copper Water Tube (Metric)
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM B 280	(1997) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B 650	(1995) Electrodeposited Engineering Chromium Coatings of Ferrous Substrates
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM C 67	(1997) Sampling and Testing Brick and Structural Clay Tile
ASTM C 534	(1994) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 916	(1985; R 1996) Adhesives for Duct Thermal Insulation
ASTM C 1071	(1998) Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)
ASTM D 520	(1984; R 1995) Zinc Dust Pigment

ASTM D 596	(1991; R 1995) Reporting Results of Analysis of Water
ASTM D 1384	(1997a) Corrosion Test for Engine Coolants in Glassware
ASTM D 1784	(1996) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2000	(1998) Rubber Products in Automotive Applications
ASTM D 3308	(1997) PTFE Resin Skived Tape
ASTM E 84	(1998e1) Surface Burning Characteristics of Building Materials
ASTM E 437	(1992) Industrial Wire Cloth and Screens (Square Opening Series)
ASTM F 104	(1993) Nonmetallic Gasket Materials
ASTM F 872	(1984; R 1990) Filter Units, Air Conditioning: Viscous-Impingement Type, Cleanable

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15	(1994) Safety Code for Mechanical Refrigeration
ASHRAE 34	(1992; Addenda a-j) Number Designation and Safety Classification of Refrigerants
ASHRAE 52.1	(1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
ASHRAE 64	(1995) Methods of Testing Remote Mechanical-Draft Evaporative Refrigerant Condensers
ASHRAE 127	(1988) Method of Testing for Rating Computer and Data Processing Room Unitary Air-Conditioners

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel

	Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995; B16.22a) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(1986; R 1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.1	(1998) Power Piping
ASME B31.5	(1992; B31.5a) Refrigeration Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME PTC 23	(1986; Addenda 1992, R 1992) Atmospheric Water Cooling Equipment

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(1997) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS Brazing Hdbk	(1991) Brazing Handbook
AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
AWS D1.1	(1998) Structural Welding Code - Steel

ASSOCIATION OF HOME APPLIANCE MANUFACTURERS (AHAM)

AHAM Directory	(1997) Directory of Certified Room Air Conditioners

CALIFORNIA REDWOOD ASSOCIATION (CRA)

CRA RIS-01-55	(1997) Standard Specifications for Grades of California Redwood Lumber

COOLING TOWER INSTITUTE (CTI)

CTI ATC-105	(1997) Acceptance Test Code
CTI Std-103	(1994) The Design of Cooling Towers with Redwood Lumber
CTI Std-111	(1998) Gear Speed Reducers
CTI Std-114	(1996) The Design of Cooling Towers with Douglas Fir Lumber
CTI Std-134	(1996) Plywood for Use in Cooling Towers
CTI Std-137	(1994) Fiberglass Pultruded Structural Products for Use in Cooling Towers
CTI WMS-112	(1986) Pressure Preservative Treatment of Lumber

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(1993; Addenda 1995; Errata 1996; 7th Ed. 1998) EJMA Standards

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.5	(1994) Centrifugal Pumps

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(1995) Butterfly Valves
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(1998) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

MSS SP-110	(1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures
NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3 Rev 4) Motors and Generators
NEMA MG 2	(1989) Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1996; Errata) National Fuel Gas Code
NFPA 70	(1999) National Electrical Code
NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems
NFPA 214	(1996) Water-Cooling Towers
NFPA 255	(1996) Method of Test of Surface Burning Characteristics of Building Materials

NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION (NAIMA)

NAIMA AH115	(1993) Fibrous Glass Duct Construction Standards

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Install Fire Damp HVAC	(1992) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
SMACNA TAB HVAC Sys	(1993; Addenda Nov 1997) HVAC Duct Construction Standards - Metal and Flexible
SMACNA Leakage Test Mnl	(1985) HVAC Air Duct Leakage Test Manual

UNDERWRITERS LABORATORIES (UL)

UL 181	(1996; Rev Dec 1998) Factory-Made Air Ducts and Air Connectors
UL 207	(1993; Rev thru Oct 1997) Refrigerant-Containing Components and Accessories, Nonelectrical

UL 214	(1997) Tests for Flame-Propagation of Fabrics and Films
UL 484	(1993; Rev thru Oct 1998) Room Air Conditioners
UL 555	(1995) Fire Dampers
UL 586	(1996) High-Efficiency, Particulate, Air Filter Units
UL 723	(1996) Test for Surface Burning Characteristics of Building Materials
UL 900	(1994; Rev thru Apr 1997) Test Performance of Air Filter Units
UL 1995	(1995; Rev thru Jul 98) Heating and Cooling Equipment
UL Bld Mat Dir	(1998) Building Materials Directory
UL Elec Const Dir	(1998) Electrical Construction Equipment Directory
UL Fire Resist Dir	(1998) Fire Resistance Directory (2 Vol.)

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA Grading Rules	(1995; Supple Nos. 1 thru 5) Western Lumber Grading Rules 95

1.2 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Air-Conditioning/Heat Pump System; [_____].

Manufacturer's standard catalog data, prior to the purchase or installation of a particular component, shall be highlighted to show brand name, model number, size, options, performance charts and curves, etc. in sufficient detail to demonstrate compliance with contract requirements. Data shall be submitted for each specified component. Data shall include manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

Water Treatment Systems; [_____].

[Six] [_____] complete copies of the proposed water treatment plan including a layout, control scheme, a list of existing make-up water conditions, a list of the types and proportions of chemicals used, the final treated water conditions, and a description of all environmental concerns for handling the chemicals.

Spare Parts Data; [_____].

Spare parts data for each different item of equipment specified, after approval of detail drawings and not later than [_____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

SD-04 Drawings

Air-Conditioning/Heat Pump System; [_____].

Drawings shall provide adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

(1) Equipment layouts which identify assembly and installation details.

(2) Piping layouts which identify valves and fittings.

(3) Plans and elevations which identify clearances required for maintenance and operation.

(4) Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

(5) Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.

(6) Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

(7) Automatic temperature control diagrams and control sequences.

(8) Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

SD-06 Instructions

Framed Instructions; FIO.

Framed instructions for posting, at least 2 weeks prior to construction completion.

SD-07 Schedules

Tests; FIO.

A letter, at least [10] [_____] working days in advance of each tests, advising the Contracting Officer of the test. Individual letters shall be submitted for the condenser water system, refrigerant system, ductwork leak tests, cooling tower tests, condenser water quality tests, and the system performance tests. Each letter shall identify the date, time, and location for each test.

Demonstrations; GA.

A letter, at least 14 working days prior to the date of the proposed training course, which identifies the date, time, and location for the training.

SD-08 Statements

Qualifications; [_____].

A letter listing the qualifying procedures for each welder. The letter shall include supporting data such as test procedures used, what was tested etc., and a list of the names of qualified welders and their identification symbols.

Verification of Dimensions; FIO.

A letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found.

SD-09 Reports

Tests; GA.

[Six] [_____] copies of each test containing the information described below in bound 8-1/2 x 11 inch booklets. Individual reports shall be submitted for the condenser water system, refrigerant system, ductwork leak tests, and the cooling tower tests.

(1) The date the tests were performed.

(2) A list of equipment used, with calibration certifications.

(3) Initial test summaries.

(4) Repairs/adjustments performed.

(5) Final test results.

Condenser Water Quality Tests; [_____].

Test reports, each month for a period of one year after project completion, in bound 8-1/2 x 11 inch booklets. The reports shall identify the chemical composition of the condenser water. The reports shall also include a comparison of the manufacturer's recommended operating conditions for the cooling tower and condenser in relation to the condition of the condenser water. Any required corrective action shall be documented within the report.

System Performance Tests; GA.

[Six] [_____] copies of the report shall be provided in bound 8-1/2 x 11 inch booklets. The report shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report shall also include the following information and shall be taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart:

(1) Date and outside weather conditions.

(2) The load on the system based on the following:

(a) The refrigerant used in the system.
(b) Condensing temperature and pressure.
(c) Suction temperature and pressure.
(d) Ambient, condensing and coolant temperatures
(e) Running current, voltage and proper phase sequence for each phase of all motors.

(3) The actual on-site setting of operating and safety controls.

(4) Thermostatic expansion valve superheat - value as determined by field test

(5) Subcooling

(6) High and low refrigerant temperature switch set-points

(7) Low oil pressure switch set-point

(8) Defrost system timer and thermostat set-points

(9) Moisture content

(10) Capacity control set-points

(11) Field data and adjustments which affect unit performance and energy consumption.

(12) Field adjustments and settings which were not permanently marked as an integral part of a device.

Inspections; [_____].

Test report, at the completion of one year of service, in bound 8-1/2 x 11 inch booklets. The report shall identify the condition of the cooling tower and condenser. The report shall also include a comparison of the condition of the cooling tower and condenser with the manufacturer's recommended operating conditions.

SD-13 Certificates

Air-Conditioning/Heat Pump System; [_____].

Where the system, components, or equipment are specified to comply with requirements of ARI, ASHRAE, ASME, or UL, proof of such compliance shall be provided. The label or listing of the specified agency shall be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard ARI rating conditions, computer printouts, catalog, or other application data certified by ARI or a nationally recognized laboratory as described above shall be included. If ARI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

Service Organizations; [_____].

A certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

SD-19 Operation and Maintenance Manuals

Operation Manual; [_____].

[Six] [_____] complete copies of an operation manual in bound 8-1/2 x 11 inch booklets listing step-by-step procedures required for system startup, operation, and shutdown. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

Maintenance Manual; [_____].

[Six] [_____] complete copies of maintenance manual in bound 8-1/2 x 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

Water Treatment Systems; [_____].

[Six] [_____] complete copies of operating and maintenance manuals for the step-by-step water treatment procedures. The manuals shall include testing procedures used in determining water quality.

1.3 QUALIFICATIONS

****

NOTE: If the need exists for more stringent requirements for weldments, delete the first bracketed statement, otherwise delete the second.

****

[Piping shall be welded in accordance with the qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.] [Welding and nondestructive testing procedures shall be as specified in Section 05093 WELDING PRESSURE PIPING.] Structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL.

1.4 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather and contamination. Proper protection and care of all material before, during, and after installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.5.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions. Equipment, ductwork, and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

PART 2 PRODUCTS

****

NOTE: Inapplicable equipment and system requirements will be deleted or modified in all paragraphs to suit the system designed. Coordinate the standard and design option features typical for each Air-Conditioning/Heat Pump unit and individual installation. Care must be taken to avoid specifying design options which are generally unavailable in certain combinations or are inappropriate for the application.

Projects which include vapor-compression type

refrigeration systems will comply with the safety standards defined in ASHRAE 15. Designers will be responsible for thoroughly researching and implementing the ASHRAE 15 safety requirements. For refrigerant-containing parts (excluding piping) located within an indoor space, a designer can use the following 6-step synopsis as a guide in determining "System Application Requirements" from ASHRAE 15.

Step 1. Identify the safety group classification of the refrigerant anticipated to be used in the new refrigeration equipment. Refrigerants R-22 and R-134a are considered Group A1 refrigerants. Refrigerant R-123 is considered a Group B1 Refrigerant.

Step 2. Identify the occupancy classification of the facility which will house the new refrigerant equipment. Occupancies include institutional, public assembly, residential, commercial, large mercantile, industrial, and mixed types.

Step 3. Determine the system probability (high or low) of the new refrigeration equipment. Split system applications are typically considered high-probability systems according to ASHRAE 15.

Step 4. Estimate the quantity of refrigerant (grams or pounds) in the largest single refrigerant circuit of the new equipment. The designer will research catalog data from different manufacturers in order to get an approximation.

Step 5. Determine the volume (cubic meters or cubic feet) of the indoor space which is planned to house the new refrigeration equipment.

Step 6. Identify the "System Application Requirements" from the applicable table in ASHRAE 15 based upon the information identified in the previous steps (e.g., safety group, occupancy, system probability, refrigerant quantity, and indoor space volume). The "System Application Requirements" will dictate applicable refrigerant limitations as well as occupied space or mechanical room requirements.

ASHRAE 15 refers to a mechanical room as a machinery room, however the terms are synonymous. On mechanical room design, ASHRAE 15 touches on criteria concerning equipment placement, ventilation design, door and passageway restrictions, refrigerant monitoring, open-flame devices,

pressure-relief and purge piping. In addition to mechanical room design, ASHRAE 15 also touches on criteria concerning refrigerant piping, signs, self-contained breathing apparatus (SCBA), and miscellaneous installation restrictions. (SCBAs cannot be considered MCA funded items and are therefore not included in this specification.)
****

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

2.2 NAMEPLATES

****
NOTE: In a salt water environment substitute acceptable non-corroding metal such as but not limited to nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.
****

Major equipment including compressors, condensers, receivers, heat exchanges, fans, cooling towers, pumps and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of [anodized aluminum] [stainless steel] [_____]. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.3 ELECTRICAL WORK

****
NOTE: Where motor starters for mechanical equipment are provided in motor-control centers, the references to motor starters will be deleted.
****

Electrical equipment, motors, motor efficiencies, and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall be as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Gaskets

Gaskets shall conform to ASTM F 104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

2.4.2 Bolts and Nuts

Bolts and nuts, except as required for piping applications, shall be in accordance with ASTM A 307. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A 307.

2.4.3 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.4.4 Escutcheons

Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

2.4.5 Pressure and Vacuum Gauge

Gauge shall conform to ASME B40.1, Class 1, 2, or 3, Style X, Type I or III as required, 4-1/2 inches in diameter with phenolic or metal case. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

2.4.6 Temperature Gauges

Industrial duty thermometers shall be provided for the required temperature range. Thermometers shall have Fahrenheit scale in 2 degree graduations scale on a white face. The pointer shall be adjustable.

2.4.6.1 Stem Cased-Glass

Stem cased-glass case shall be polished stainless steel or cast aluminum, 9 inches long, with clear acrylic lens, and non-mercury filled glass tube.

2.4.6.2 Bimetallic Dial

Bimetallic dial type case shall be not less than 3-1/2 inches, stainless steel, and shall be hermetically sealed with clear acrylic lens. Bimetallic element shall be silicone dampened and unit fitted with external calibrator adjustment. Accuracy shall be one percent of dial range.

2.4.6.3 Liquid-, Solid-, and Vapor-Filled Dial

Liquid-, solid-, and vapor-filled dial type cases shall be not less than 3-1/2 inches, stainless steel or cast aluminum with clear acrylic lens. Fill shall be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

2.4.6.4 Thermal Well

Thermal well shall be identical size, 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 1 inch.

2.4.7 Unicellular Plastic Foam

Unicellular plastic foam shall be in accordance with ASTM C 534, Form T, except that D-Factor shall not exceed 0.28 at 75 degrees F mean temperature.

2.4.8 Bird Screen

Screen shall be in accordance with ASTM E 437, Type 1, Class 1, 2 by 2 mesh, 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire.

2.5 UNITARY EQUIPMENT, ROOM UNIT

2.5.1 Window or Through-the-Wall Mounted Unit

****
NOTE: Indicate unit capacity, voltage, phase, installation requirements, etc. on the drawings.
****

Unit shall be a [window] [through-the-wall] mounted, appliance grade, factory assembled air-conditioner unit. Unit shall be in accordance with AHAM Directory and UL 484. Units shall include a self-contained, precharged, slide-in and removable chassis-mounted, air-cooled refrigeration system. Cooling section shall be equipped with a filter-drier on the suction line. Fan and condenser motors shall have [open] [dripproof] [totally enclosed] [explosion proof] enclosures.

2.5.2 Packaged Terminal Unit

Unit shall be a through-the-wall mounted, heavy-duty commercial grade, factory assembled and precharged [air-conditioner] [heat pump] unit. Unit shall be in accordance with ARI 310/380 and UL 1995. Units shall be removable from inside the building for servicing without removing the outside cabinet. Unit shall have a noise rating in accordance with ARI 350 and not exceed [_____] bels while the entire unit is operating at any fan or compressor speed. Heat pump units shall contain a reversing valve to change unit to heating cycle. An outdoor coil temperature sensor shall be provided to guard against coil freeze-up by either switching to supplemental heat only, or by cycling the compressor to defrost the coil.

2.5.3 Compressor

Compressor shall be hermetically sealed reciprocating, rotary, or scroll type. Compressor shall be fitted with permanent split capacitor motor, overload protection, and vibration isolators. Compressor shall be protected against high discharge pressure, loss of charge, low voltage, and short cycling.

2.5.4 Air-To-Refrigerant Coils

****

NOTE: Delete the copper or aluminum tubes and the 0.076 mm (3 mil) coating except in corrosive environments.

****

Evaporator and condenser coils shall have [nonferrous] [copper or aluminum] tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coils shall be protected with a minimum 3 mil thick [phenolic] [or] [vinyl] coating. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. A condensate removal system shall be provided.

2.5.5 Fans

Indoor and outdoor fans shall be the centrifugal, direct driven type. Fans shall be statically and dynamically balanced. Outdoor fan shall be designed so that condensate will evaporate without drip, splash, or spray on building exterior. Indoor fan shall be provided with a minimum two-speed motor with built-in overload protection. Fan motors shall be the inherently protected, permanent split-capacitor type.

2.5.6 Air Filters

Filters shall be of the sectional or panel cleanable type and be capable of filtering the entire air supply.

2.5.7 Primary/Supplemental Heat

[Primary] [Supplemental] heat shall be provided as specified in paragraph "System Components".

2.5.8 Cabinet Construction

****
NOTE: The cabinet subbase is optional and should be deleted if not necessary.
****

Cabinet shall be free of visible fasteners, sharp protuberances and edges. Enclosure sheet metal shall be a minimum of 18 gauge steel with a protective coating. Face panels shall be removable and shall provide full access to unit appurtenances. Access to controls shall be without removal of the face panel. Conditioned air shall discharge through adjustable louvers. Cabinet shall be thermally and acoustically insulated with materials which conform to NFPA 90A. Units shall be furnished with a [field-wired] [prewired] subbase. Subbase shall have leveling screws [with] [without] provisions for remote unit control. Subbase shall be of 18 gauge galvanized steel construction with a protective coating to match that of the room cabinet. Paint and finishes shall comply with the requirements specified in paragraph "Factory Coating".

2.5.9 Wall Sleeve

Louver shall be stormproof type, constructed of anodized, stamped or extruded aluminum. Sleeve shall be a water and airtight [completely insulated] [noninsulated] assembly, with weather-resistant protective coating.

2.5.10 Duct Package

Duct extension shall consist of 18 gauge minimum galvanized steel plenum extender with all necessary internal dampers and baffles to divert [_____] percent of the supply air as indicated. Duct extension shall be painted with a protective coating that matches room cabinet.

2.5.11 Unit Controls

Controls shall include an on-off switch, high and low selector switch for [the cooling mode] [both the heating and cooling mode], multiple speed fan [cooling] [cooling and heating] mode, room air fan switch, outside air damper control, and an adjustable cooling [only] [and heating] thermostat. Function and temperature controls shall be [integral to unit] [remotely mounted as indicated or as accepted by the Contracting Officer].

2.6 UNITARY EQUIPMENT, PACKAGE SYSTEM

****
NOTE: Air-cooled, water-cooled, and evaporatively-cooled air-conditioning units with capacities less than 39.5 kW (135,000 Btuh) will be rated in accordance with ARI 210/240.

Air-cooled, water-cooled, and evaporatively-cooled air-conditioning and heat pump units with capacities greater than or equal to 39.5 kW (135,000 Btuh) will be rated in accordance with ARI 340/360.

Air-cooled heat pump units with capacities less than 39.5 kW (135,000 Btuh) will be rated in accordance with ARI 210/240.

Water-cooled heat pumps used in closed water loop systems (water-source systems) will be rated in accordance with ARI ANSI/ARI 320.

Water-cooled heat pumps used in open ground water loop systems (groundwater-source systems) will be rated in accordance with ARI 325. Delete the last 2 sentences if an open-loop type unit is not specified.

Specify a sound rating of 8.4 bels for outdoor units with capacities below 11.1 kW (38,000 Btuh). Specify a sound rating of 8.6 bels for outdoor units with capacities between 11.1 kW (38,000 Btuh) and 19 kW (65,000 Btuh). Specify a sound rating of 8.8 bels for outdoor units with capacities greater than 19 kW (65,000 Btuh). Specify ARI 270 for sound ratings for outdoor units with capacities less than 39.5 kW (135,000 Btuh), otherwise specify ARI 370.

Include the last sentence only if a water-cooled unit is specified and the supply water temperature is capable of falling below 65 degrees F in any mode of heat pump operation.

At a minimum, efficiencies for packaged systems will be in accordance with paragraph "Equipment Efficiency". Package systems are typically available in 2 different efficiency ranges; conventional efficiency and high efficiency. Conventional efficiency units typically have an EER value between 8.5 and 9.5 depending upon the size of the unit. High efficiency units typically have an EER value between 9.5 and 10.5. The efficiency to specify for a packaged system will be based upon an economic comparison. Coordinate the efficiency specified with manufacturers.
****

Unit shall be an [air-cooled] [water-cooled] [evaporatively-cooled] factory assembled, [weatherproof] [indoor] packaged unit as indicated. Unit shall be the [air-conditioning] [heat pump] type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be rated in accordance with [ARI 210/240] [ARI 340/360] [ARI ANSI/ARI 320] [ARI 325]. Unit shall be provided with equipment as specified in paragraph "System Components". Evaporator or supply fans shall be double-width, double inlet, forward curved, backward inclined, or airfoil blade, centrifugal scroll type. Motors shall have [open] [dripproof] [totally enclosed] [explosion proof] enclosures. Condenser fans shall be manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged with refrigerant and oil in accordance with manufacturer's recommendations. Outdoor unit shall produce a maximum ARI sound rating of [8.4] [8.6] [8.8] [_____] bels in accordance with [ARI 270] [ARI 370]. [Interior water source piping shall be insulated as a "cold pipe" described in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.] [Water-cooled unit shall be fitted with a strainer protected solenoid shut-off valve. The valve shall be a fully automatic, self-contained temperature regulating valve with integral thermometer.]

2.6.1 Air-to-Refrigerant Coils

****

NOTE: Delete the copper or aluminum tubes and the 0.076 mm (3 mil) coating except in corrosive environments.

****

Air-to-refrigerant coils shall have [nonferrous] [copper or aluminum] tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coils shall be protected with a minimum 3 mil thick [phenolic] [or] [vinyl] coating. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.6.2 Water-to-Refrigerant Coils

****

NOTE: Delete this paragraph if water-cooled packaged units are not specified. Delete the inapplicable fouling factor. In areas where poor water conditions exist or where water conditions are unknown, the 0.001 factor will be specified. In areas where water is known to be noncorrosive the 0.0005 fouling factor will be specified. Water-cooled condensers may be used for refrigerant storage in lieu of a separate liquid receiver, if the condenser storage capacity is 20 percent in excess of the fully charged system.

****

Coils shall be of the tube-in-tube, shell-and-coil, shell-and-tube, or concentric tube type and be provided as an integral part of the packaged unit. Water-wetted metals shall be [copper] [or] [90/10] [or] [70/30] [copper-nickel], except that heads may be ferrous metal in systems with chemically treated recirculating water. Coils shall be rated for not less than 400 psi refrigerant side and 125 psi water side pressure service at operating temperatures. Coils shall be supplied with water as indicated. Water supply, return and control system wetted parts shall be copper, bronze or stainless steel. Water supply, return connections and piping internal to unit shall be copper with brazed or threaded copper or bronze fittings, terminating in a threaded connection. Piping arrangement shall include valved access for recirculation of acidic scale removal chemicals and isolation pressure taps to determine pressure drop and water flow. Performance shall be based on an allowable water velocity not less than 3 fps nor more than 10 fps with a fouling factor of [0.001] [0.0005].

2.6.3   Evaporatively-Cooled Section

****
NOTE: Delete this paragraph and subparagraphs if an evaporatively-cooled packaged unit is not specified.
****

The evaporative section shall be a packaged component of the unitary equipment. Unit shall be the counter-flow blow-through design, with single-side air entry. Unit shall have fan assemblies built into the unit base, with all moving parts factory mounted and aligned. Primary construction of the pan section, the cabinet, etc. shall be not lighter than 16-gauge steel, protected against corrosion by a zinc coating. The zinc coating shall conform to ASTM A 153/A 153M and ASTM A 123/A 123M, as applicable and a minimum coating thickness of 2-1/2 ounces per square foot of surface. Cut edges shall be given a protective coating of zinc-rich compound. After assembly, the manufacturer's standard zinc chromatized aluminum or epoxy paint finish shall be applied to the exterior of the unit.

2.6.3.1   Pan Section

The pan shall be watertight and be provided with drain, overflow, and make-up water connections. Standard pan accessories shall include circular access doors, a lift-out strainer of anti-vortexing design and a brass make-up valve with float ball.

2.6.3.2   Fan Section

Fan shall be the [centrifugal] [propeller] type in accordance with paragraph "Fans". Fan and fan motor shall not be located in the discharge airstream of the unit. Motors shall have [open] [splashproof] [totally enclosed] enclosure and be suitable for the indicated service. The unit design shall prevent water from entering into the fan section.

2.6.3.3   Condensing Coil

****
NOTE: Delete the copper or aluminum tubes and the 0.076 mm (3 mil) coating except in corrosive environments.
****

Coils shall have [nonferrous] [copper or aluminum] tubes of 3/8 inch minimum diameter without fins. Coils shall be protected with a minimum 3 mil thick [phenolic] [or] [vinyl] coating. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system.

2.6.3.4   Water Distribution System

Water shall be distributed uniformly over the condensing coil to ensure complete wetting of the coil at all times. Spray nozzles shall be brass, stainless steel, or high-impact plastic. Nozzles shall be the cleanable, nonclogging, removable type. Nozzles shall be designed to permit easy disassembly and be arranged for easy access.

2.6.3.5   Water Pump

The water pump shall be the bronze-fitted centrifugal or turbine type, and may be mounted as an integral part of the unit or remotely on a separate mounting pad. Pumps shall have cast-iron casings. Impellers shall be bronze, and shafts shall be stainless steel with bronze casing wearing rings. Shaft seals shall be the mechanical type. Pump casing shall be factory coated with epoxy paint. Pump motors shall have [open] [dripproof] [totally enclosed] [explosion proof] enclosures. A bleed line with a flow valve or fixed orifice shall be provided in the pump discharge line and shall be extended to the nearest drain for continuous discharge. Pump suction shall be fully submerged and provided with a galvanized steel or monel screened inlet.

2.6.3.6 Drift Eliminator

Eliminators shall be provided to limit drift loss to not over 0.005 percent of the specified water flow. Eliminators shall be constructed of zinc-coated steel or polyvinyl chloride (PVC). Eliminators shall prevent carry over into the unit's fan section.

2.6.3.7 Evaporator Controls

Unit shall be provided with modulating capacity control dampers mounted in the discharge of the fan housing. On a decrease in refrigerant discharge pressure the dampers shall modulate to reduce the airflow across the condensing coil. Controls shall include a proportional acting pressure controller, a control transformer, motor actuator with linkages and end switches to cycle fan motor on and off. Cycling of a fan motor on and off shall be in accordance with the manufacturer.

2.6.4 Compressor

Compressor shall be direct drive, semi-hermetic or hermetic reciprocating, or scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors of 10 tons and larger shall be provided with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors shall operate in sequence, and each compressor shall have an independent refrigeration circuit through the condenser and evaporator. Compressors shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, thermal overloads, [lubrication pump,] [high] [high and low] pressure safety cutoffs and protection against short cycling.

2.6.5 Refrigeration Circuit

****

NOTE: Filter-driers are optional and may be deleted on most precharged systems.

****

Refrigerant containing components shall comply with ASHRAE 15 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant charging valves and connections, and pumpdown valves shall be provided for each circuit. Filter-drier shall be provided in each liquid line and be reversible-flow type. Refrigerant flow control devices shall be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control, and a pilot solenoid controlled, leak-tight, four-way refrigerant flow reversing valve.

2.6.6 Unit Controls

****

NOTE: Insert in the blank appropriate minimum or lowest expected ambient temperature. Delete head pressure controls if inapplicable. Delete low cost cooling if inapplicable. In those areas where the outdoor seasonal climatic conditions permit, an outdoor temperature sensing unit (dry bulb) may be used in an external control circuit to take advantage of outside air to satisfy the cooling load. Under such conditions, the control circuit would lock out the compressors and position the outdoor and return air dampers to allow 100 percent fresh air to be circulated. Enthalpy controls will not be used.

****

Unit shall be internally prewired with a [24] [120] [_____] volt control circuit powered by an internal transformer. Terminal blocks shall be provided for power wiring and external control wiring. Unit shall have cutoffs for [high] [high and low] pressure, [and] low oil pressure for compressors with positive displacement oil pumps, [supply fan failure] [and safety interlocks on all service panels]. Head pressure controls shall sustain unit operation with ambient temperature of [_____]. Adjustable-cycle timers shall prevent short-cycling. Multiple compressors shall be staged by means of a time delay. Unit shall be internally protected by fuses or a circuit breaker in accordance with UL 1995. Low cost cooling shall be made possible by means of a control circuit which will modulate dampers to provide 100 percent outside air while locking out compressors.

2.7 UNITARY EQUIPMENT, SPLIT SYSTEM

****

NOTE: A remote condensing unit includes both the condensing coil and the compressor. A remote condenser includes only the condensing coil.

Air-cooled, water-cooled, and evaporatively-cooled air-conditioning units with capacities less than 39.5 kW (135,000 Btuh) will be rated in accordance with ARI 210/240.

Air-cooled, water-cooled, and evaporatively-cooled air-conditioning and heat pump units with capacities greater than or equal to 39.5 kW (135,000 Btuh) will be rated in accordance with ARI 340/360.

Air-cooled heat pump units with capacities less than 39.5 kW (135,000 Btuh) will be rated in accordance with ARI 210/240.

Water-cooled heat pumps used in closed water loop systems (water-source systems) will be rated in accordance with ARI ANSI/ARI 320.

Water-cooled heat pumps used in open ground water loop systems (groundwater-source systems) will be rated in accordance with ARI 325.

At a minimum, efficiencies for split-systems will be in accordance with paragraph "Equipment Efficiency". Single phase split systems are typically available with SEER values of 10, 11, 12, or 14. Three phase split systems are typically available in 2 different efficiency ranges; conventional efficiency and high efficiency. Conventional efficiency units typically have an EER value between 8.5 and 9.5 depending upon the size of the unit. High efficiency units typically have an EER value between 9.5 and 10.5. The efficiency to specify for a split-system will be based upon an economic comparison. Coordinate the efficiency specified with manufacturers.
****

Unit shall be an [air-cooled] [water-cooled] [evaporatively-cooled], split system which employs a remote [condenser] [condensing unit], a separate indoor unit, and interconnecting refrigerant piping. Unit shall be the [air-conditioning] [heat pump] type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be rated in accordance with [ARI 210/240] [ARI 340/360] [ARI ANSI/ARI 320] [ARI 325]. Unit shall be provided with necessary fans, air filters, [coil frost protection,] [liquid receiver,] internal dampers, mixing boxes, supplemental heat, and cabinet construction as specified in paragraph "System Components". The remote unit shall be as specified in paragraph REMOTE CONDENSER OR CONDENSING UNIT. Evaporator or supply fans shall be double-width, double inlet, forward curved, backward inclined, or airfoil blade, centrifugal scroll type. Condenser or outdoor fans shall be the manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Fan and condenser motors shall have [open] [dripproof] [totally enclosed] [explosion proof] enclosures.

2.7.1 Air-to-Refrigerant Coil

****
NOTE: Delete the copper or aluminum tubes and the 0.076 mm (3 mil) coating except in corrosive environments.
****

Coils shall have [nonferrous] [copper or aluminum] tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coils shall be protected with a minimum 3 mil thick [phenolic] [or] [vinyl] coating. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.7.2 Compressor

****

NOTE: Delete this paragraph if a remote condensing unit is specified.

****

Compressor shall be direct drive, semi-hermetic or hermetic reciprocating, or scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors of 10 tons and larger shall be provided with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors will operate in sequence, and each compressor shall have an independent refrigeration circuit through the condenser and evaporator. Each compressor shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, thermal overloads, [lubrication pump,] [high] [high and low] pressure safety cutoffs and protection against short cycling.

2.7.3 Refrigeration Circuit

****

NOTE: Filter-driers are optional and may be deleted on most precharged systems. Delete the last two sentences if an integral water-cooled condenser is not specified.

****

Refrigerant-containing components shall comply with ASHRAE 15 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant charging valves and connections, and pumpdown valves shall be provided for each circuit. Filter-drier shall be provided in each liquid line and be reversible-flow type. Refrigerant flow control devices shall be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control, and a pilot solenoid controlled, leak-tight, four-way refrigerant flow reversing valve. A refrigerant suction line [thermostatic] [thermostatic and water flow switch] control shall be provided to prevent freeze-up in event of loss of water flow during heating cycle.

2.7.4 Unit Controls

****

NOTE: Insert in the blank appropriate minimum or lowest expected ambient temperature. Delete head pressure controls if inapplicable. Delete low cost cooling if inapplicable. In those areas where the outdoor seasonal climatic conditions permit, an outdoor temperature sensing unit (dry bulb) may be used in an external control circuit to take advantage of outside air to satisfy the cooling

load. Under such conditions, the control circuit would lock out the compressors and position the outdoor and return air dampers to allow 100 percent fresh air to be circulated. Enthalpy controls will not be used.
****

Unit shall be internally prewired with a [24] [120] [_____] volt control circuit powered by an internal transformer. Terminal blocks shall be provided for power wiring and external control wiring. Unit shall have cutoffs for [high] [high and low] pressure, [and] low oil pressure for compressors with positive displacement oil pumps, [supply fan failure], [and safety interlocks on all service panels]. Head pressure controls shall sustain unit operation with ambient temperature of [_____] degrees F. Adjustable-cycle timers shall prevent short-cycling. Multiple compressors shall be staged by means of a time delay. Unit shall be internally protected by fuses or a circuit breaker in accordance with UL 1995. Low cost cooling shall be made possible by means of a control circuit which will modulate dampers to provide 100 percent outside air while locking out compressors.

2.8 AIR-CONDITIONERS FOR ELECTRONIC DATA PROCESSING (EDP) SPACES

****
NOTE: Indoor units are inherently noisy. In noise sensitive areas, steps should be taken to attenuate sound.

Air-cooled and water-cooled air-conditioning units with capacities less than 39.5 kW (135,000 Btuh) will be rated in accordance with ARI 210/240.

Air-cooled, water-cooled, and evaporatively-cooled air-conditioning units with capacities greater than or equal to 39.5 kW (135,000 Btuh) will be rated in accordance with ARI 340/360.

Delete the last sentence if an integral water-cooled condenser or a packaged air-cooled unit is specified.

Inapplicable equipment and system requirements will be deleted or modified in all paragraphs to suit the system designed. Coordinate the standard and design option features typical for each Air-Conditioner/Heat Pump unit and individual installation. Care must be taken to avoid specifying design options which are generally unavailable in certain combinations or are inappropriate for the application.
****

Unit shall be an [air-cooled] [water-cooled], self-contained type air-conditioning unit. Unit shall be [a packaged unit with an internal water-cooled condenser] [a split-system with a remote [condenser] [condensing unit]]. Unit shall be designed and constructed for automatic control of space conditions. Unit shall be in accordance with ASHRAE 127 and UL 1995. Unit shall be rated in accordance with [ARI 210/240] [ARI 340/360]. ARI certification is not required. The system shall be designed and constructed for maximum reliability and ease of maintenance. Necessary redundancy, access to refrigeration circuits, means of troubleshooting, and malfunction alarms shall be provided. Unit shall be provided with necessary fans, air filters, [coil frost protection,] [liquid receiver,] internal dampers, mixing boxes, supplemental heat, and cabinet construction as specified in paragraph "System Components". Evaporator or supply fans shall be double-width, double inlet, forward curved centrifugal scroll type. Condenser or outdoor fans shall be manufacturer's standard for unit specified and may be either propeller or centrifugal scroll type. Fan and condenser motors shall have [open] [dripproof] [totally enclosed] [explosion proof] enclosures. [Remote unit shall be as specified in paragraph REMOTE CONDENSER/CONDENSING UNIT.]

2.8.1 Air-to-Refrigerant Coils

****

NOTE: Delete the copper or aluminum tubes and the 0.076 mm (3 mil) coating except in corrosive environments.

****

[Evaporator] [Evaporator and condenser] coils shall have [nonferrous] [copper or aluminum] tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coils shall be protected with a minimum 3 mil thick [phenolic] [or] [vinyl] coating. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Units shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.8.2 Water-to-Refrigerant Coils

****

NOTE: Delete this paragraph if a remote condenser/condensing unit is specified. Delete the last two sentences if a once-thru water source is not used in conjunction with the self-contained unit.

Delete the inapplicable fouling factor. In areas where poor water conditions exist or where water conditions are unknown, the 0.001 factor will be specified. In areas where water is known to be noncorrosive the 0.0005 fouling factor will be specified. The inapplicable fouling factor will be deleted. Water-cooled condensers may be used for refrigerant storage in lieu of a separate liquid receiver, if the condenser storage capacity is 20 percent in excess of the fully charged system.

****

Unit shall be of the tube-in-tube, shell-and-coil, shell-and-tube, or concentric tube type and be provided as an integral part of the self-contained unit. Water-wetted metals shall be [copper] [or] [90/10] [or] [70/30] [copper-nickel], except that heads may be ferrous metal in systems with chemically treated recirculating water. Unit shall be rated for not less than 400 psi refrigerant side and 125 psi water side pressure service at operating temperatures. Unit shall be supplied with water as indicated. Water supply, return and control system wetted parts shall be copper, bronze or stainless steel. Water supply, return connections and piping internal to unit shall be copper with brazed or threaded copper or bronze fittings, terminating in a threaded connection. Piping arrangement shall include valved access for recirculation of acidic scale removal chemicals and isolation pressure taps to determine pressure drop and water flow. Performance shall be based on an allowable water velocity not less than 3 fps nor more than 10 fpswith a fouling factor of [0.001] [0.0005]. A separate condenser shall be provided for each compressor circuit. Control shall be set for refrigerant condensing temperature of [_____] degrees F. Units which use a once-thru water-source shall be fitted with a strainer protected solenoid shut-off valve. The valve shall be a fully automatic, self-contained temperature regulating valve with integral thermometer.

2.8.3 Compressor

****

NOTE: Delete this paragraph if a remote condensing unit is specified.

****

Compressor shall be direct drive, semi-hermetic or hermetic reciprocating, or scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors of 7-1/2 tons and larger shall be provided with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors will operate in sequence, and each compressor shall have an independent refrigeration circuit through the condenser and evaporator. Each compressor shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, [lubrication pump,] thermal overloads, and [high] [high and low] pressure safety cutoffs and protection against short cycling.

2.8.4 Refrigeration Circuit

****

NOTE: Filter-driers are optional and may be deleted on most precharged systems. Delete the last two sentences except when needed for a self-contained heat pump with an integral water-cooled condenser.

****

Refrigerant-containing components shall comply with ASHRAE 15 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant charging valves and connections, and pumpdown valves shall be provided for each circuit. Filter-drier shall be provided in each liquid line and be reversible-flow type. Refrigerant flow control devices shall be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control, and a pilot solenoid controlled, leak-tight, four-way refrigerant flow reversing valve. A refrigerant suction line [thermostatic] [thermostatic and water flow switch] control shall be provided to prevent freeze-up in event of loss of water flow during heating cycle.

2.8.5 Unit Controls

A unit's basic functions and space ambient conditions shall be controllable at one station. A temperature and humidity strip-chart recorder, integral or external to the unit, readable to specified control accuracy, shall be provided, complete with cartridge ink and chart supply for 1 year of operation.

2.8.5.1 Externally Accessible Controls

The following controls shall be externally accessible:

a. Start and stop total system functions.

b. Audible alarm silence.

c. Main power disconnect.

2.8.5.2 Status Indicators

The following status indicators shall be externally visible:

a. Power On.

b. System On.

c. Malfunction.

d. Provision for remote alarm status indication.

2.8.5.3 Alarmed Conditions

The following system status conditions shall be both audibly and visually alarmed:

a. Loss of air flow.

b. Dirty filters.

c. Compressor overload or lock-out (compressor high head pressure and low suction pressure).

d. [High] [High and low] room temperature.

e. High humidity alarm at [_____] percent relative humidity.

2.8.5.4 Space Temperature

Space temperature shall be controlled within plus or minus 1-1/2 degrees F of the set point over a range of 60 to 90 degrees F with a set point of [_____]. Space relative humidity shall be controlled within plus or minus 5 percent of the set point over a range of 20 to 80 percent with a set point of [_____] percent.

2.8.5.5   Safety Controls

Safety controls shall include the following:

a. Fused, unfused or line-break circuit breaker disconnects, as indicated or required.

b. Automatic pump-out or pump-down liquid flooding controls.

c. High refrigerant pressure cutout.

d. Low refrigerant pressure cutout where automatic pump-down is not provided.

e. Accessible hermetic and open compressor low oil pressure cutout.

f. Elapsed time meter for each compressor where load equalization is not incorporated.

g. Lead and lag compressor selector switch, when compatible with system.

2.8.6   Cabinet Construction

****

NOTE: Delete the last sentence if inapplicable.

****

Cabinet shall be totally enclosed. Enclosure surfaces shall be pulsation free, with hinged and removable doors and panels for vertical side or front access to unit components. Routine maintenance access to compressor and system control components shall be possible without unit shut-down. Enclosure surfaces shall be thermally and acoustically insulated. Interior baffle and compartment surfaces shall be galvanized steel. Drain pans shall collect all condensate and be steel with external insulation as required. Surface mounting steel pads and vibration isolating pads shall be provided. Enclosure surfaces shall be prepared, primed and finished. Paint and finishes shall comply with the requirements specified in paragraph "Factory Coating". Cabinets shall be fitted with integral or separable, adjustable and lockable jacks to support the units from the structural slab at the raised-floor elevation.

2.9   EQUIPMENT EFFICIENCY

****

NOTE: Use this note to determine the minimum equipment efficiencies required for all equipment specified. Present applicable efficiencies either in this paragraph or on the design drawings. Delete this paragraph if equipment efficiencies are shown on the drawings.

The following is a list of terms which are commonly used in regard to efficiency ratings.

COP - Coefficient of Performance (dimensionless)
EER - Energy Efficiency Ratio (Btuh/Watt)

HSPF - Heating System Performance Factor (Btuh/Watt)
SEER - Seasonal Energy Efficiency Ratio (Btuh/Watt)
SCOP - Seasonal Coefficient of Performance (dimensionless)
IPLV - Integrated Part Load Value (dimensionless)

COP and HSPF values are typically used in regard to heating efficiencies. COP values should also be used to define cooling efficiencies when a job is being specified in SI units (EER = 3.415 x COP). COP and EER values are established based strictly upon a unit's full load capacity and not part load capacities.

Equipment selected will have as a minimum the efficiency rating determined in the following paragraphs. The minimum efficiencies will be determined based upon the standards referenced (i.e. ARI 210/240, ARI 340/360, etc.) Equipment having a higher efficiency may be specified if the designer determines the equipment to be more life-cycle cost effective.

ARI 210/240: The following is a list of minimum efficiencies for equipment rated in accordance with ARI 210/240 (Packaged Unitary Systems, Split Unitary Systems, and EDP Air-Conditioners). The efficiencies are based on the standard ratings conditions defined in ARI 210/240.

AIR-COOLED, SPLIT AND PACKAGE SYSTEMS
Capacity less than 19 kW (less than 65,000 Btuh)
Cooling Mode
SEER = 10.0 (1 Phase)
EER = 9.5 (3 Phase)
IPLV = 8.5 (3 Phase)
Heating Mode
HSPF = 6.6 (1 Phase)
COP = 3.0 (High Temp Rating, 3 Phase)
COP = 2.0 (Low Temp Rating, 3 Phase)

Capacity greater than or equal to 19 kW and less than 39.5 kW (greater than or equal to 65,000 and less than 135,000 Btuh)
Cooling Mode
EER = 8.9 (All Phases)
IPLV = 8.3 (All Phases)
Heating Mode
COP = 3.0 (High Temperature Rating, All Phases)
COP = 2.0 (Low Temperature Rating, All Phases)

EVAPORATIVELY-COOLED, SPLIT AND PACKAGE SYSTEMS
Capacity less than 19 kW (less than 65,000 Btuh)

Cooling Mode
EER = 9.3

Capacity greater than or equal to 19 kW and less than 39.5 kW (greater than or equal to 65,000 and less than 135,000 Btuh)
Cooling Mode
EER = 10.5

WATER-COOLED, SPLIT AND PACKAGED SYSTEMS
Capacity less than 19 kW (less than 65,000 Btuh)
Cooling Mode
EER = 9.3
IPLV = 8.3

Capacity greater than or equal to 19 kW and less than 39.5 kW (greater than or equal to 65,000 and less than 135,000 Btuh)
Cooling Mode
EER = 10.5

ARI 340/360: The following is a list of minimum efficiencies for equipment rated in accordance with ARI 340/360 (Packaged Unitary Systems, Split Unitary Systems, and EDP Air-Conditioners). The efficiencies are based on the standard ratings conditions defined in ARI 340/360.

AIR-COOLED, SPLIT AND PACKAGE SYSTEMS
Capacity greater than or equal to 39.5 kW (greater than or equal to 135,000 Btuh)
Cooling Mode
EER = 8.9
IPLV = 7.5
Heating Mode
COP = 2.9 (High Temp Rating)
COP = 2.0 (Low Temp Rating)

WATER-COOLED, SPLIT AND PACKAGED SYSTEMS
Capacity greater than or equal to 39.5 kW (greater than or equal to 135,000 Btuh)
Cooling Mode
EER = 9.6
IPLV = 9.0

ARI 320: The following is a list of minimum efficiencies for equipment rated in accordance with ARI 320 (Water-source heat pumps used in Packaged and Split Unitary Systems). The efficiencies are based on the standard ratings conditions defined in ARI 320.

WATER-COOLED, SPLIT AND PACKAGE SYSTEMS
Capacity less than 19 kW (less than 65,000 Btuh)
Cooling Mode
EER = 9.3 (Standard Rating)
EER = 10.2 (Low Temp. Rating)
Heating Mode
COP = 3.8 (Standard Rating)
COP = 3.4 (High Temp Rating)
COP = 3.0 (Low Temp Rating)

Capacity greater than or equal to 19 kW (greater than or equal to 65,000 Btuh)
Cooling Mode
EER = 10.5 (Standard Rating)
Heating Mode
COP = 3.8 (Standard Rating)
COP = 3.4 (High Temp Rating)
COP = 3.0 (Low Temp Rating)

ARI 325: The following is a list of minimum efficiencies for equipment rated in accordance with ARI 325 (Groundwater-source heat pumps used in Packaged and Split Unitary Systems). The efficiencies are based on the standard ratings conditions defined in ARI 325.

GROUNDWATER-COOLED, SPLIT AND PACKAGE SYSTEMS
Cooling Mode (All Capacities)
EER = 11.0 (Standard Rating)
EER = 11.5 (Low Temp. Rating)

Heating Mode (All Capacities)
COP = 3.8 (Standard Rating)
COP = 3.4 (High Temp Rating)
COP = 3.0 (Low Temp Rating)

ARI 310/380: The following is a list of minimum efficiencies for equipment rated in accordance with ARI 310/380 (Packaged Terminal Units). The efficiencies are based on the standard ratings conditions defined in ARI 310/380.

PACKAGED TERMINAL UNITS
Cooling Mode
Capacity less than or equal to 2.0 kW (less than or equal to 7,000 Btuh)
EER = 9.5
Capacity greater than 2.0 and less than or equal to 2.9 kW (greater than 7,000 and less than or equal to 10,000 Btuh)
EER = 9.0
Capacity greater than 2.9 and less than or equal to

3.5 kW (greater than 10,000 and less than or equal to 12,000 Btuh)
EER = 8.5
Capacity greater than 3.5 kW (greater than 12,000 Btuh)
EER = 8.0

Heating Mode (All Capacities)
COP = 2.7 (Standard Rating)

For multi-capacity equipment, the minimum performance shall apply to each capacity step provided and allowed by the controls.

AHAM Directory: The following is a list of minimum efficiencies for equipment rated in accordance with AHAM Directory (Window or Through-the-Wall Room Units). The efficiencies are based on the standard ratings conditions defined in AHAM Directory.

ROOM UNITS
Without Reverse Cycle and with Louvered Sides
Capacity less than or equal to 1.8 kW (less than 6,000 Btuh)
EER = 8.0
Capacity greater than 1.8 and less than or equal to 2.3 kW (greater than 6,000 and less than or equal to 8,000 Btuh)
EER = 8.5
Capacity greater than 2.3 and less than or equal to 4.0 kW (greater than 8,000 and less than or equal to 14,000 Btuh)
EER = 9.0
Capacity greater than 4.0 and less than or equal to 5.9 kW (greater than 14,000 and less than or equal to 20,000 Btuh)
EER = 8.8
Capacity greater than or equal to 5.9 kW (greater than 20,000 Btuh)
EER = 8.2

Without Reverse Cycle and without Louvered Sides
Capacity less than or equal to 1.8 kW (less than 6,000 Btuh)
EER = 8.0
Capacity greater than 1.8 and less than or equal to 5.9 kW (greater than 6,000 and less than or equal to 20,000 Btuh)
EER = 8.5
Capacity greater than or equal to 5.9 kW (greater than 20,000 Btuh)
EER = 8.0

With Reverse Cycle and With Louvered Sides
All Capacities
EER = 8.5

With Reverse Cycle and Without Louvered Sides
All Capacities
EER = 8.0
****

Unit shall have an efficiency [of[_____]] [as indicated on the drawings].

2.10 REMOTE CONDENSER OR CONDENSING UNIT

****
NOTE: Delete the sound requirements unless the unit is located in a sound-sensitive area.
****

Units with capacities less than 135,000 Btuh shall produce a maximum ARI sound rating of [_____] bels when rated in accordance with ARI 270. Units with capacities 135,000 Btuh or greater shall produce a maximum ARI sound rating of [_____] bels when rated in accordance with ARI 370. Each remote condenser coil shall be fitted with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature shall not exceed 120 degrees F at 95 degrees F ambient. Unit shall be provided with low ambient condenser controls to ensure proper operation in an ambient temperature of [_____] degrees F. Fan and cabinet construction shall be provided as specified in paragraph "System Components". Fan and condenser motors shall have [open] [dripproof] [totally enclosed] [explosion proof] enclosures.

2.10.1 Air-Cooled Condenser

Unit shall be rated in accordance with ARI 460 and conform to the requirements of UL 1995. Unit shall be factory fabricated, tested, packaged, and self-contained. Unit shall be complete with casing, propeller or centrifugal type fans, heat rejection coils, connecting piping and wiring, and all necessary appurtenances.

2.10.1.1 Connections

Interconnecting refrigeration piping, electrical power, and control wiring between the condensing unit and the indoor unit shall be provided as required and as indicated. Electrical and refrigeration piping terminal connections between [condenser] [condensing unit] and evaporator units shall be provided.

2.10.1.2 Head Pressure Control and Liquid Subcooling

Low ambient control for multi-circuited units serving more than one evaporator coil shall provide independent condenser pressure controls for each refrigerant circuit. Controls shall be set to produce a minimum of 95 degrees F saturated refrigerant condensing temperature. Unit shall be provided with a liquid subcooling circuit which shall ensure proper liquid refrigerant flow to the expansion device over the specified application range of the condenser. Unit shall be provide with [manufacturer's standard] [not less than [8] [_____] degrees F] liquid subcooling. Subcooling circuit shall be liquid sealed.

2.10.1.3 Condensing Coil

****

NOTE: Delete the copper or aluminum tubes and the 0.076 mm (3 mil) coating except in corrosive environments.

****

Coils shall have [nonferrous] [copper or aluminum] tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coils shall be protected with a minimum 3 mil thick [phenolic] [or] [vinyl] coating. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.10.1.4 Unit Controls

The control system shall be complete with required accessories for regulating condenser pressure by fan cycling, solid-state variable fan speed, modulating condenser coil or fan dampers, flooding the condenser, or a combination of the above. Unit mounted control panels or enclosures shall be constructed in accordance with applicable requirements of NFPA 70 and housed in NEMA ICS 6, Class 1 or 3A enclosures. Controls shall include [control transformer,] [fan motor [starters,]] [solid-state speed control,] [electric heat tracing controls,] [time delay start-up,] overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

2.10.2 Evaporative Condenser

Each unit shall be the counter-flow blow-through design, with single-side air entry. The unit shall have fan assemblies built into the unit base, with all moving parts factory mounted and aligned. Primary construction of the pan section, the cabinet, etc. shall be not lighter than 16-gauge steel, protected against corrosion by a zinc coating. The zinc coating shall conform to ASTM A 153/A 153M and ASTM A 123/A 123M, as applicable and have an extra heavy coating of not less than 2-1/2 ounces per square foot of surface. Cut edges shall be given a protective coating of zinc-rich compound. After assembly, the manufacturer's standard zinc chromatized aluminum or epoxy paint finish shall be applied to the exterior of the unit. Unit shall be rated in accordance with ARI 490 and tested in accordance with the requirements of ASHRAE 64.

2.10.2.1 Pan Section

The pan shall be watertight and be provided with drain, overflow, and make-up water connections. Standard pan accessories shall include circular access doors, a lift-out strainer of anti-vortexing design and a brass make-up valve with float ball.

2.10.2.2 Fan Section

Fan shall be the [centrifugal] [propeller] type in accordance with paragraph "Fans". Fan and fan motor shall not be located in the discharge airstream of the unit. Motors shall have [open] [splashproof] [totally enclosed] enclosure and be suitable for the indicated service. The condensing unit design shall prevent water from entering into the fan section.

2.10.2.3 Condensing Coil

****

NOTE: Delete the copper or aluminum tubes and the 0.076 mm (3 mil) coating except in corrosive environments.

****

Coils shall have [nonferrous] [copper or aluminum] tubes of 3/8 inch minimum diameter without fins. Coils shall be protected with a minimum 3 mil thick [phenolic] [or] [vinyl] coating. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged.

2.10.2.4 Water Distribution System

Water shall be distributed uniformly over the condensing coil to ensure complete wetting of the coil at all times. Spray nozzles shall be brass, stainless steel, or high-impact plastic. Nozzles shall be the cleanable, nonclogging, removable type. Nozzles shall be designed to permit easy disassembly and be arranged for easy access.

2.10.2.5 Water Pump

The water pump shall be the bronze-fitted centrifugal or turbine type, and may be mounted as an integral part of the evaporative condenser or remotely on a separate mounting pad. Pumps shall have cast-iron casings. Impellers shall be bronze, and shafts shall be stainless steel with bronze casing wearing rings. Shaft seals shall be the mechanical type. Pump casing shall be factory coated with epoxy paint. Pump motors shall have [open] [dripproof] [totally enclosed] [explosion proof] enclosures. A bleed line with a flow valve or fixed orifice shall be provided in the pump discharge line and shall be extended to the nearest drain for continuous discharge. Pump suction shall be fully submerged and provided with a galvanized steel or monel screened inlet.

2.10.2.6 Drift Eliminator

Eliminators shall be provided to limit drift loss to not over 0.005 percent of the specified water flow. Eliminators shall be constructed of zinc-coated steel or polyvinyl chloride (PVC). Eliminators shall prevent carry over into the unit's fan section.

2.10.2.7 Unit Controls

The evaporative condenser unit shall be provided with modulating capacity control dampers mounted in the discharge of the fan housing. On a decrease in refrigerant discharge pressure the dampers shall modulate to reduce the airflow through the evaporative condenser. Controls shall include a proportional acting pressure controller, a control transformer, motor actuator with linkages and end switches to cycle fan motor on and off. Cycling of a fan motor on and off shall be in accordance with the manufacturer.

2.10.3   Compressor

****

NOTE: Delete this paragraph if only a remote condenser is required.

****

Unit shall be rated in accordance with ARI 500. Compressor shall be direct drive, semi-hermetic or hermetic reciprocating, or scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Units 120,000 Btuh and larger shall be provided with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors will operate in sequence, and each compressor shall have an independent refrigeration circuit through the condenser and evaporator. Each compressor shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, [lubrication pump,] thermal overloads, and [high] [high and low] pressure safety cutoffs and protection against short cycling.

2.11   DRY-COOLER, GLYCOL SOLUTION

Unit shall be factory fabricated and tested, packaged, self-contained, complete with casing, propeller or centrifugal type fans, heat rejection coils, appurtenances, and intercomponent piping and wiring. Unit shall be certified by the manufacturer or an independent test laboratory that the unit's ratings meet ARI 410 the indicated conditions. Unit shall be designed for [outdoor] [indoor] installation and comply with the requirements of UL 1995. Unit shall compatible with the solution specified in paragraph "Glycol Solution". Unit shall be fitted with [duplex] recirculating pump, expansion tank, [black steel] [Type L copper] [schedule 80 PVC] intercomponent piping, system accessories and controls. Factory assembled piping shall be Type L copper. Cabinet construction shall be in accordance with paragraph "System Components".

2.11.1   Coil

****

NOTE: Delete the copper or aluminum tubes and the 0.076 mm (3 mil) coating except in corrosive environments.

****

Coils shall have [nonferrous] [copper or aluminum] tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coils shall be protected with a minimum 3 mil thick [phenolic] [or] [vinyl] coating. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.11.2 Fan Section

Fan shall be the [centrifugal] [propeller] type in accordance with paragraph "Fans". Motors shall have [open] [dripproof] [totally enclosed] [explosion proof] enclosures and be suitable for the indicated service.

2.11.3 Pump

Pump and controls shall be mounted within a lockable sheet metal enclosure supported from dry cooler structure. Pump shall be of the end-suction type with an [open] [dripproof] [totally enclosed] [explosion proof] motor. Pump construction shall be as specified in paragraph "Pumps". Seals shall be mechanical type suitable for ethylene glycol solution up to a 60 percent concentration of glycol, and be rated for 180 degrees F service.

2.11.4 Controls

The control system shall be complete with all required accessories for regulating glycol temperature by [fan cycling.] [solid-state variable fan speed.] [modulating glycol 3-way mixing valve or modulating fan dampers.] Unit-mounted control panels or enclosures shall be constructed in accordance with applicable requirements of NFPA 70 and housed in NEMA ICS 6, Class 1 or 3A enclosures. Controls shall include a [control transformer,] [fan motor [starters,]] [solid-state speed control,] [pump motor starters,] [electric heat tracing controls,] [time delay start-up,] overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

2.12 SYSTEM COMPONENTS

****

NOTE: System components which are not referenced from the equipment specified above, excluding refrigerant and oil, will be deleted.

****

2.12.1 Refrigerant and Oil

****

NOTE: R-22, R-123 and R-134a all meet the ODP requirement of 0.05. R-22 is the most commonly used refrigerant.

****

Refrigerant shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ASHRAE 34. Refrigerants shall meet the requirements of ARI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.05. Contractor shall provide and install a complete charge of refrigerant for the installed system as recommended by the manufacturer. Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase shall be furnished. One charge shall be used during the system performance testing period. Following the satisfactory completion of the performance testing, the oil shall be drained and replaced with a second charge. Lubricating oil shall be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge shall be in accordance with manufacturer's recommendation.

2.12.2 Fans

Fan wheel shafts shall be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans shall be selected to produce the cfm required at the fan total pressure. Motor starters, if applicable, shall be magnetic across-the-line type with a [open] [dripproof] [totally enclosed] [explosion proof] enclosure. Thermal overload protection shall be of the manual or automatic-reset type. Fan wheels or propellers shall be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings shall be of galvanized steel, and both centrifugal and propeller fan casings shall be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, shall be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting shall be recoated with an approved zinc-rich compound. Fan wheels or propellers shall be statically and dynamically balanced. Forward curved fan wheels shall be limited to [_____] inches. Direct-drive fan motors shall be of the multiple-speed variety. Belt-driven fans shall have adjustable sheaves to provide not less than [_____] percent fan-speed adjustment. The sheave size shall be selected so that the fan speed at the approximate midpoint of the sheave adjustment will produce the specified air quantity. Centrifugal scroll-type fans shall be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. Propeller fans shall be [direct-drive] [V-belt] drive type with [adjustable] [fixed] pitch blades. V-belt driven fans shall be mounted on a corrosion protected drive shaft supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Each drive will be independent of any other drive. Drive bearings shall be protected with water slingers or shields. V-belt drives shall be fitted with guards where exposed to contact by personnel and [fixed pitch] [adjustable pitch] sheaves.

2.12.3 Primary/Supplemental Heating

****

NOTE: Inapplicable types of heating coils will be deleted. In some cases, unitary products are not available with steam or water heating coils.

****

2.12.3.1 Water Coil

****

NOTE: Drainable coils will be specified where coils are subject to freezing during the heating season. If drainable coils are not required, delete the last sentence.

****

Coil shall conform to the provisions of ARI 410. Coil shall be fin-and-tube type constructed of seamless copper tubes and [aluminum] [or] [copper] fins mechanically bonded or soldered to tubes. Headers shall be constructed of cast iron, welded steel or copper. Coil shall be constructed to float within the casing to allow free expansion and contraction of tubing. Casing and tube support sheets shall not be lighter than 16 gauge galvanized steel formed to provide structural strength. When required, multiple tube supports shall be provided to prevent tube sag. Coil shall be circuited for suitable water velocity without excessive pressure drop and properly pitched for drainage where required or indicated. Each coil shall be tested at the factory under water at not less than 300 psi air pressure, tested hydrostatically after assembly of the unit and proved tight under a gauge pressure of 200 psi. Coil shall be suitable for use with water up to 250 degrees F. Coil shall allow complete coil drainage with a pitch of not less than 1/8 inch per foot slope to drain.

2.12.3.2 Steam Coil

Coil shall conform to the provisions of ARI 410. Coil shall be constructed of cast semi-steel, welded steel, or copper headers, red-brass or copper tubes, and copper or aluminum fins mechanically bonded or soldered. Tubes shall be rolled and bushed and brazed or welded into headers. Coil casings and tube support sheets, with collars of ample width, shall be not lighter than 16 gauge galvanized steel, formed to provide structural strength. When required, multiple tube supports shall be provided to prevent tube sag. The fin tube and header section shall float within the casing to allow free expansion of tubing for coils subject to high pressure-steam service. Coils shall be factory pressure tested and capable of withstanding 250 psi hydrostatic test pressure or 250 psi air pressure, and be for [100] [200] psi steam working pressure. Preheat coils shall be steam-distributing tube type. Condensing tubes shall be not less than 5/8 inch outside diameter. Distribution tubes shall be not less than 3/8 inch outside diameter, and be equipped with orifices to discharge steam to condensing tubes. Distribution tubes shall be installed concentrically inside of condenser tubes and be held securely in alignment. The maximum length of a single coil shall be limited to 120 times the diameter of the outside tube. Other heating coils shall be minimum 1/2 inch outside diameter single-tube type. Supply headers shall distribute steam evenly to all tubes at the indicated steam pressure. Coil shall allow complete coil drainage with a pitch of not less than 1/8 inch per foot slope to drain.

2.12.3.3 Electric Heating Coil

****

NOTE: Choose the second set of brackets if an air-conditioning unit for EDP is specified.

****

Coil shall be an electric duct heater in accordance with UL 1995 and NFPA 70. Coil shall be duct- or unit-mounted. Coil shall be of the [nickel chromium resistor, single stage, strip] [nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type. Coil shall be provided with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Coil casing and support brackets shall be of galvanized steel or aluminum. Coil shall be mounted to eliminate noise from expansion and contraction and be completely accessible for service.

2.12.3.4   Gas Fired Heating Section

****
NOTE: Gas fired heating sections are not available for air-conditioning units for EDP spaces.
****

Gas fired heat exchanger shall be constructed of aluminized steel, ceramic coated cold-rolled steel or stainless steel suitable for [natural gas] [liquid propane gas] fuel supply. Burner shall have direct spark or hot surface ignition. Valve shall include a pressure regulator. Combustion air shall be supplied with a centrifugal combustion air blower. Safety controls shall include a flame sensor and air pressure switch. Heater section shall be mounted to eliminate noise from expansion and contraction and shall be completely accessible for service. Gas equipment shall bear the AGA label for the type of service involved. Burner shall be in accordance with NFPA 54.

2.12.4   Air Filters

****
NOTE: References to inapplicable filter types will be deleted.
****

Air filters shall be listed in accordance with requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test Method shall be as listed under the label service and shall meet the requirements of UL 586.

2.12.4.1   Extended Surface Pleated Panel Filters

Filters shall be 2 inch depth sectional type of the size indicated and shall have an average efficiency of 25 to 30 percent when tested in accordance with ASHRAE 52.1. Initial resistance at 500 feet per minute will not exceed 0.36 inches water gauge. Filters shall be UL Class 2. Media shall be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. Four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

2.12.4.2   Replaceable Media Filters

Replaceable media filters shall be the [dry-media] [viscous adhesive] type, of the size required to suit the application. Filtering media shall be not less than 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Pad shall be enclosed in a holding frame of not less than 16 gauge galvanized steel, and equipped with quick-opening mechanism for changing filter media. The air flow capacity of the filter shall be based on net filter face velocity not exceeding [300] [_____] feet per minute, with initial resistance of [0.13] [_____] inches water gauge. Average efficiency shall be not less than [_____] percent when tested in accordance with ASHRAE 52.1.

2.12.4.3   Sectional Cleanable Filters

****

NOTE: Delete the last three sentences if a washing and cleaning unit is not necessary.
****

Cleanable filters shall conform to ASTM F 872, and be [1 inch] [2 inches] thick. Viscous adhesive shall be provided in 5 gallon containers in sufficient quantity for 12 cleaning operations and not less than one quart for each filter section. Initial pressure drop for clean filters shall not exceed the applicable values listed in ASTM F 872. One washing and charging tank shall be provided for every 100 filter sections or fraction thereof. Each washing and charging unit shall consist of a tank and [single] [double] drain rack mounted on legs. Drain rack shall be provided with dividers and partitions to properly support the filters in the draining position.

2.12.5 Coil Frost Protection

****
NOTE: If coil frost protection is required, manufacturer's recommended coil frost protection systems shall be evaluated. If the manufacturer's standard coil frost protection is not appropriate, determine if a hot gas bypass system is an economical and practical coil frost protection system and modify the specification as required.
****

Each circuit shall be provided with a coil frost protection system which is a manufacturer's standard. The coil frost protection system shall use a temperature sensor in the suction line of the compressor to shut the compressor off when coil frosting occurs. Timers shall be used to prevent the compressor from rapid cycling.

2.12.6 Pressure Vessels

Pressure vessels shall conform to ASME BPV VIII Div 1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Where referenced publications do not apply, pressure components shall be tested at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces shall be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed.

2.12.6.1 Hot Gas Muffler

Unit shall be selected by the manufacturer for maximum noise attenuation. Units rated for 30 tons capacity and under may be field tunable type.

2.12.6.2 Liquid Receiver

A liquid receiver shall be provided when a system's condenser or compressor does not contain a refrigerant storage capacity of at least 20 percent in excess of a fully charged system. Receiver shall be designed, filled, and rated in accordance with the recommendations of ARI 495, except as modified herein. Receiver shall be fitted to include an inlet connection; an outlet drop pipe with oil seal and oil drain where necessary; two bull's-eye liquid level sight glass in same vertical plane, 90 degrees apart and perpendicular to axis of receiver or external gauge glass with metal guard and automatic stop valves; [thermal well for thermostat;] [float switch column;] [external float switches;] and purge, charge, equalizing, pressurizing, plugged drain and service valves on the inlet and outlet connections. Receiver shall be provided with a relief valve of capacity and setting in accordance with ASHRAE 15.

2.12.6.3   Oil Separator

Separator shall be the high efficiency type and be provided with removable flanged head for ease in removing float assembly and removable screen cartridge assembly. Pressure drop through a separator shall not exceed [10] [_____] psi during the removal of hot gas entrained oil. Connections to compressor shall be as recommended by the compressor manufacturer. Separator shall be provided with an oil float valve assembly or needle valve and orifice assembly, drain line shutoff valve, sight glass, [filter for removal of all particulate sized 10 microns and larger,] [thermometer and low temperature thermostat fitted to thermal well,] [immersion heater,] [external float valve fitted with three-valve bypass,] and strainer.

2.12.6.4   Oil Reservoir

Reservoir capacity shall equal one charge of all connected compressors. Reservoir shall be provided with an external liquid gauge glass, plugged drain, and isolation valves. Vent piping between the reservoir and the suction header shall be provided with a 5 psi pressure differential relief valve. Reservoir shall be provided with the manufacturer's standard filter on the oil return line to the oil level regulators.

2.12.7   Internal Dampers

****
NOTE: Specify the sequence of operation of all damper operations on the drawings.
****

Dampers shall be parallel blade type with renewable blade seals and be integral to the unitary unit. Damper provisions shall be provided for each outside air intake, exhaust, economizer, and mixing boxes. Dampers shall [have minimum position stops] [be linked together] [have [manual] [automatic] modulation] and operate as specified.

2.12.8   Mixing Boxes

Mixing boxes shall match the base unit in physical size and shall include equally-sized [flanged] openings, each capable of full air flow. Arrangement shall be as indicated.

2.12.9   Cabinet Construction

****
NOTE: Delete this paragraph if room air-conditioner/heat pumps or air-conditioners for EDP spaces are specified.
****

Casings for the specified unitary equipment shall be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces shall be 18 gauge galvanized steel or 071 inch thick aluminum on units with a capacity above 20 tons and 20 gauge galvanized steel or 0.064 inch thick aluminum on units with a capacity less than 20 tons. Casing shall be fitted with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Where double-wall insulated construction is proposed, minimum exterior galvanized sheet metal thickness shall be 20 gauge. Provisions to permit replacement of major unit components shall be incorporated. Penetrations of cabinet surfaces, including the floor, shall be sealed. Unit shall be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan shall be fabricated from Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation shall be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces shall prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation shall conform to ASTM C 1071. Paint and finishes shall comply with the requirements specified in paragraph "Factory Coating".

2.12.9.1 Indoor Cabinet

Indoor cabinets shall be suitable for the specified indoor service and enclose all unit components.

2.12.9.2 Outdoor Cabinet

Outdoor cabinets shall be suitable for outdoor service with a weathertight, insulated and corrosion-protected structure. Cabinets constructed exclusively for indoor service which have been modified for outdoor service are not acceptable.

2.12.10 Humidifier

2.12.10.1 Steam Spray Type

Steam spray humidifiers shall inject steam directly into the [surrounding air] [or] [air stream]. [Single grid humidifiers shall consist of a single copper distribution grid with pipe connection on one end and cap on the other end. Automatic steam control valves and condenser traps shall be field-installed.] [Enclosed grid shall be housed in a copper enclosure with a built-in condensate drain connection. Exposed grid shall be wick wrapped.] [Package type steam spray humidifiers shall be equipped to trap out and to evaporate condensate and to supply dry steam to a single distribution grid. Grid shall be steam jacketed and condensate drained. Unit shall trap excess condensate to return system. Package type steam spray humidifiers shall have modulating electric, electronic, or pneumatic steam control valve, as indicated.] Steam spray humidifiers shall be rated for humidifying capacity in pounds of steam per hour and at steam pressure as indicated.

2.12.10.2 Steam-Diffuser Type

Diffuser units shall be of a design that will separate any condensate from steam supply and provide positive drain of condensate to waste and supply dry steam only to air stream. Humidifiers may be installed on single or multiple units. Materials shall be [noncorrosive materials] [Type 300 stainless steel].

2.13 PUMPS

****

NOTE: Indicate on the drawings pump capacity, efficiencies, motor sizes, and impeller types. Typical impeller types include the double-suction horizontal split-case type, end-suction vertical split-case type, close-coupled end-suction type, close-coupled in-line type.

****

Pumps shall be the electrically driven, non-overloading, centrifugal type which conform to HI 1.1-1.5. Pump capacity, efficiency, motor size, and impeller type shall be as indicated on the drawings. Pumps shall be selected at or near peak efficiency. Pump curve shall rise continuously from maximum capacity to shutoff. Shutoff head shall be approximately 20 percent greater than design head. Pump motor shall be totally enclosed and have sufficient horsepower for the service required. Each pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in the cover.

2.13.1 Construction

Shaft seal shall be mechanical-seal or stuffing-box type. Impeller shall be statically and dynamically balanced. Each pump casing shall be designed to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than 125 psi. Pump casing and bearing housing shall be close grained cast iron. High points in the casing shall be provided with manual air vents; low points shall be provided with drain plugs. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Shaft shall be carbon or alloy steel, turned and ground. Bearings shall be ball-bearings, roller-bearings, or oil-lubricated bronze-sleeve type bearings, and be efficiently sealed or isolated to prevent loss of oil or entrance of dirt or water. Pump motors, unless otherwise indicated, shall have [open] [dripproof] [totally enclosed] [explosion proof] enclosures. [Pump and motor shall be mounted on a common cast iron base having lipped edges and tapped drainage openings or structural steel base with lipped edges or drain pan and tapped drainage openings.] [Pump shall be provided with shaft coupling guard.] [Close coupled pumps shall be provided with drip pockets and tapped openings.] Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pump speed shall not exceed 3,600 rpm, except where the pump head is less than 60 feet of water, the pump speed shall not exceed 1,750 rpm. Pump shall be accessible for servicing without disturbing piping connections.

2.13.2 Mechanical Shaft Seals

Seals shall be single, inside mounted, end-face-elastomer bellows type with stainless steel spring, brass or stainless steel seal head, carbon rotating face, and tungsten carbide sealing face. Glands shall be bronze and of the water-flush design to provide lubrication flush across the face of the seal. Bypass line from pump discharge to flush connection in gland shall be provided, with filter or cyclone separator in line.

2.13.3 Stuffing-Box Type Seals

Seals shall be single unit construction separate from the casing, secured against rotation. Stuffing box shall include minimum 5 rows of square, graphite braided asbestos packing and a bronze split-lantern ring. Packing gland shall be bronze interlocking split type.

2.14   COOLING TOWER

****

NOTE: Locate the tower in accordance with NFPA 214, and determine the extent and type of fire protection required for all size towers using the factors indicated in NFPA 214. Concrete structured towers are selected for their longevity over conventional type, but are considerably more expensive and should be used only if cost effective. PVC fill for concrete towers is considerably less expensive and should be specified unless tile fill can be justified. When project requirements limit the use of wood construction in cooling towers, all references to wood construction will be removed.

****

2.14.1   Fire Safety

Towers shall conform to NFPA 214. Fire hazard rating for plastic impregnated materials shall not exceed 25. Plastics shall not drip or run during combustion. Determine ratings by ASTM E 84 or NFPA 255.

2.14.2   Lumber

Lumber required for cooling tower construction shall be as defined by the following type woods:

2.14.2.1   Douglas Fir

CTI Std-114, WWPA Grading Rules, Grade B and better, Industrial Clear. Douglas fir shall have a preservative treatment in accordance with CTI WMS-112.

2.14.2.2   Plywood

CTI Std-134, Exterior Grade, type and thickness as specified for the application.

2.14.2.3   Pressure Treated Lumber

Pressure treated lumber shall be in accordance with CTI WMS-112. Wood exposed as the result of notching, cutting, or drilling shall be saturated with the preservative.

2.14.2.4   Redwood

CTI Std-103, CRA RIS-01-55 California Redwood, clear of all hearts.

2.14.3   Fiberglass Reinforced Plastic (FRP)

FRP components shall be inert, corrosion resistant, and fire-retardant with a thickness of 12 ounces per square foot. FRP components shall contain an ultraviolet (UV) ray inhibitor as per CTI Std-137, Grade 1 or 3.

2.14.4   Zinc-Coated Steel

Components fabricated of zinc-coated steel shall be not lighter than 16 gauge steel, protected against corrosion by a zinc coating. The zinc coating shall conform to ASTM A 153/A 153M and ASTM A 123/A 123M, as applicable and have an extra heavy coating of not less than 2-1/2 ounces per square foot of surface. Galvanized surfaces damaged due to welding shall be coated with zinc rich coating conforming to ASTM D 520, Type I.

2.14.5   Polyvinyl Chloride (PVC) Formed Sheets

ASTM D 1784, Type I, Grade 1 with a flame spread rating of 15 or less per ASTM E 84.

2.14.6   Hardware

Bolts shall be cadmium-plated, zinc-coated steel, or Type 304 stainless steel. Each bolt shall be provided with neoprene and cadmium-plated steel washers under the heads. Nails shall be silicon bronze, commercial bronze, or stainless steel. Hardware shall meet the salt-spray fog test as defined by ASTM B 117.

2.14.7   Noise Control

****

NOTE: Where cooling towers are in the proximity of residential, administrative, medical, or similar inhabited facility, the maximum acceptable noise limits for such applications should be determined in NC level or dBA, and coordinated with local code requirements and the cooling tower manufacturer. The noise level criteria should be scheduled on the drawing.

****

Sound power levels (in decibels with a reference pressure of 0.0002 microbar) of the cooling tower shall not exceed the maximum permitted decibel levels for the designated octave band as set forth in the following tables. Base the sound power level data for the cooling tower on tests conducted in accordance with ANSI S1.13.

Octave Band (in Hz)	63	125	250	500	1000	2000	4000	8000
Sound Power Level in dB	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]

2.14.8   Conventional Type Tower

a. Factory-Assembled: Each tower shall be the induced mechanical draft, [crossflow] [or] [counterflow], factory fabricated, factory-assembled type.

b. Field-Assembled: Each tower shall be the induced mechanical draft, [crossflow] [or] [counterflow], factory fabricated, field-assembled type. Notching structural members may be permissible only if the members are increased proportionately in size to provide equivalent strength. Framework design for wood towers shall conform to requirements of CTI Std-103 for redwood construction and CTI Std-114 for Douglas-fir construction.

2.14.8.1 Casing

****
NOTE: Delete the last two sentence if inapplicable.
****

Casing shall be constructed of [zinc-coated steel] [lumber] [Type 304 stainless steel] [FRP]. Towers shall be designed and constructed to withstand a wind pressure of not less than 30 pound-force per square foot (psf) on external surfaces. Fan decks shall be designed to withstand a live load of not less than [40] [60] psf in addition to the concentrated or distributed loads of equipment mounted on the fan decks. A 15-percent increased loading shall be included for ice or snow load. Air inlet and discharge terminations shall have flanged or lipped projections for connecting ductwork.

2.14.8.2 Cold-Water Basin

Basin shall be completely watertight and constructed of [1-1/2 inch tongue and groove lumber] [concrete in accordance with Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE, 2,500 psi Class and reinforced as indicated.] [Type 304 stainless steel] [FRP]. Basin shall be constructed and installed to ensure that air will not be entrained in outlets when operating and no water will overflow on shutdown. Each individual sump shall be provided with an individual outlet. Each outlet shall be provided with a 1/2 inch mesh, zinc-coated steel wire securely mounted to prevent trash from entering the outlet. Each basin shall be provided with overflow and valved drain connections. Each basin shall be provided with a float-controlled, makeup water valve as indicated. The makeup water shall discharge not less than 2 inches or 2 pipe diameters, whichever is greater, above the top of the basin.

2.14.8.3 Hot-Water Distribution

Design water distribution systems for each cell of each tower so that a water flow of 140 percent of specified water flow will not cause overflowing or splashing. Water distribution systems shall be accessible and permit flexibility of operation. Provide removable covers of same material and thickness as casing for entire water distribution basin. Support covers by basin sides with top of cover flush with top of basin. Provide separate regulation and stop valves for complete balancing and complete shutoff from each cell. Systems shall be self-draining and nonclogging. The water distribution system shall be either one of the following types.

a. Open Basins: Basins shall be provided with a splash box or baffles to minimize splashing of incoming hot water, holes that evenly distribute the water over the entire decking area, and a basin cover. Holes used in a water basin shall be provided with ceramic or plastic orifice inserts.

b. Spray Nozzles: Spray nozzles shall be cleanable; stainless steel, bronze, or high-impact plastic, nonclogging, removable; and, spaced for even distribution.

2.14.8.4   Fill Material

The fill shall be the following materials as specified. PVC formed sheets arranged in a honeycomb or waveform configuration; zinc-coated steel treated Douglas-fir; or treated hemlock and treated redwood. Zinc-coated steel shall have a minimum of 2.5 ounces per square foot of surface. Fill material shall be free to expand or contract without warping. PVC fill shall not be provided when inlet temperatures exceed 125 degrees F. No plasticized wood cellulose shall be provided for fill material. Fill shall be removable or otherwise made accessible for cleaning. Provide space supports as required to prevent sagging and misalignment, and provide for an even mixing of air and water.

2.14.8.5   Drift Eliminator

Provide in tower outlet to limit drift loss to not over 0.02 percent of specified water flow. Eliminators shall be constructed of not less than 3/8 inch lumber or polyvinyl chloride (PVC).

2.14.8.6   Fan Cylinder

Each fan shall be mounted in a fan cylinder to elevate the fan discharge air. Total extension height shall not exceed the fan diameter. Fan cylinders shall be constructed of zinc-coated steel, lumber, Type 304 stainless steel, or FRP and be compatible with the entire tower construction. Each fan cylinder shall be provided with a zinc-coated steel 12 gauge wire mesh securely mounted to the top of the cylinder in accordance with manufacturer's recommendations.

2.14.8.7   Framework and Equipment Supports

Framework and equipment supports shall be zinc-coated steel [,Type 304 stainless steel,] [FRP,] or lumber. Materials provided for framework, casings and equipment supports shall be compatible.

2.14.8.8   Structural Supports

Structural supports shall be provided in accordance with the recommendations of the manufacturer of the tower unless otherwise indicated.

2.14.8.9   Foundations

****

NOTE: For the design of a tower foundation, indicate the location, the size, the reinforcement requirements, etc., necessary for a cooling tower available from 3 commonly known manufacturers. For small retrofit type jobs the designer may choose to show the general layout of the foundation and rely on the Contractor to design and construct the foundation based on the cooling tower to be provide. Delete the last 2 sentences of the paragraph if the foundation is not to be designed by the Contractor.

****

Cooling tower foundations shall meet the requirements of the cooling tower manufacturer and be as indicated. Foundation design shall be based on the load conditions and soil bearing value indicated. Foundation calculations shall be submitted with the equipment drawings.

2.14.9 Concrete Structured Type

Each tower shall be the induced mechanical draft, counterflow, factory fabricated, field-assembled type.

2.14.9.1 Casing

The wall sections shall be constructed of air entrained concrete mix. Concrete shall conform to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Exposed concrete shall be rub-finished for smooth and uniform surfaces free of form marks and defects. Honeycomb concrete shall not be permitted. Any cold-pour joints in vertical walls shall have a continuous water-stop stripping of molded polyvinyl plastic (6 inch dumbbell).

2.14.9.2 Cold-Water Basin

Basin floor slab shall be a continuous pour of high density air entrained concrete. The mix shall be of a strength to test a minimum of 4,000 psi (28 days) compressive. Air entrained cement, conforming to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE, shall be used throughout the tower structure. Structure shall contain the reinforcing steel as detailed. Standard curing measures shall be carried out to protect the concrete while "green". Exposed concrete shall be rub-finished for smooth and uniform surfaces free of form marks and defects. Honeycomb concrete shall not be permitted. A continuous water-stop stripping of molded polyvinyl plastic (6 inch dumbbell) shall be located on the centerline position of the basin wall section/floor slab intersection, and at all other cold pour joints. Basin wall sections shall be made in a second continuous pour, contain the necessary reinforcing steel as submitted by the manufacturer and approved, and be arranged to interlock with the water-stop seal in the floor slab, forming a completely waterproof basin.

2.14.9.3 Hot-Water Distribution

Distribution system for each cell shall consist of a centrally located header complete with junction boxes, side laterals, fittings, and nozzles. Piping shall be either cast iron, ductile iron, threaded-glass-fiber reinforced epoxy pipe, polypropylene, PVC or Schedule 80 black steel. Junction boxes shall be cast iron and nozzles shall be brass, stainless steel or plastic. Distribution piping including spray nozzles, pipe, fittings, and junction boxes shall be provided complete to flange face located at a point 6 inches below top of fill support beam. Provisions shall be provided for balancing of water flow between cells or spray trees.

2.14.9.4 Fill Material

Fill material shall be [tile of multicell design, set without mortar] [or] [PVC formed sheets], in a pattern, and of sufficient height to meet the performance specifications. [Tile fill shall be vitreous, with a low water absorption that will pass a freeze-thaw test conducted in accordance with ASTM C 67. Tile fill shall have a minimum crushing strength of 2,000 psi over the gross area of the tile when the load is applied parallel to the cells as tested in accordance with ASTM C 67. Cast iron tee section lintels supporting the tile fill shall conform to ASTM A 48, ASTM A 48M, Class 25, 1/8 inch additional thickness for corrosion. Lintels shall be designed with a safety factor of 2 minimum.] [PVC fill shall be manufactured from minimum nominal [20] [15] mil sheets. PVC fill shall be supported by the tower structure using corrosion resistant members. PVC sheets shall be arranged in a honeycomb or waveform configuration and shall have a flame spread rating of 25 or less when tested in accordance with ASTM E 84. Fill material shall be free to expand or contract without warping or cracking.]

2.14.9.5 Drift Eliminators

Eliminators shall be of the multi-pass zigzag type, assembled into sections making a strong, stable unit. Provide in tower outlet to limit drift loss to not over 0.005 percent of the water flow. These sections shall be supported on PVC or FRP tee sections. Tee sections shall be suspended with 1/4 inch brass rods connected to stainless steel clips embedded in the bottom side of the roof deck at the time of casting. Stainless steel clips shall be supplied by cooling tower manufacturer for installation by Contractor at time of roof deck pour. Eliminators may be supported by brass or stainless steel suspension rods from the fan deck or supported directly on concrete beams. Eliminators may be either PVC extruded sections or wave formed sheets of PVC resin conforming to ASTM D 1784 Type I, Grade 2. Eliminators and supporting framework shall have flame spread rating of 25 or less when tested in accordance with ASTM E 84.

2.14.9.6 Fan Decks and Stacks

Construct fan decks of precast, reinforced lightweight concrete, in multiple sections, forming a complete, vibration-free base for mounting fan, speed reducer, drive shaft, motor, and fan stacks. Construct fan stacks of precast, reinforced lightweight concrete in multiple sections, constrained with bands of zinc-coated steel conforming to ASTM A 123/A 123M, not less than 1/8 by 3 in., and bolted to form a compressive load on stack perimeter. Secure stack in place on fan deck with Class A mortar.

2.14.10 Louvers

Air inlets for each cooling tower shall be provided with individually removable louvers arranged to prevent the escape of water. Louvers shall be zinc-coated steel, [Type 304 stainless steel,] [FRP,] or lumber. Materials provided for casings and louvers shall be compatible; one material shall not produce stains upon the other. Louvers constructed of lumber shall be of a thickness to withstand alternate wetting and drying without cracking or splitting. Air intakes shall be provided with 1 inch zinc-coated steel mesh.

2.14.11 Fans

****

NOTE: When the density of the ambient air to be handled by the fans differs substantially from the density of the standard air value of 1.2 kg per cubic meter (0.075 pound per cubic foot) at 21.1 degrees C (70 degrees F) and 101.325 kPa (29.92 inches mercury), the density of the air and/or the elevation above mean sea level will be stated.

****

Fans shall be the [centrifugal] [or] [adjustable-pitch propeller] type, constructed of zinc-coated steel, Type 304 stainless steel, aluminum or an aluminum alloy, or FRP. Propeller type shall have a maximum tip speed of 11,000 fpm. Fan blade assembly shall be both statically and dynamically balanced after assembly of the cooling tower. Fan hub shall be constructed of [zinc-coated steel] [stainless steel] [cast aluminum] with adequate surface protection against corrosion. Complete fan assembly (fan and mounting) shall be designed to give maximum fan efficiency and long life when handling saturated air at high velocities.

2.14.12 Speed Reducer Gears and Drive Shaft

****

NOTE: Double reduction gear reducer should be considered where low noise requirement is a factor.

****

Speed reducer gears shall be rated in accordance with CTI Std-111. Gear reducers shall be of the [spiral bevel, single reduction] [spiral or helical, double reduction] type. Reducer shall be mounted in accordance with manufacturer's recommendations. Each reducer shall be provided with an oil level cutoff switch interlocked to the fan motor. Each reducer shall be provided with an oil level sight glass, fill, drain, and vent lines located in a readily accessible position. Drive shafts shall be the full floating type with flexible couplings at both ends and have a service factor of 1.0 or greater. Drive shafts shall be of stainless steel, fitted each end with flexible couplings (stainless steel plate type). Each drive shaft shall be provided with a galvanized steel guard, to prevent damage to surrounding equipment in case of shaft failure. Provision shall be made for lubrication of all bearings. Bearings shall be accessible to the extent that each bearing can be lubricated without dismantling fan.

2.14.13 Fan Motor

****

NOTE: Delete the last sentence if inapplicable.

****

Each motor shall be a [single speed] [two speed], totally enclosed, insulation Class B, NEMA Design B, continuous-rated, and conforming to NEMA MG 1. Fan motors shall have [open] [dripproof] [totally enclosed] [explosion proof] enclosures and be located outside the discharge airstream. Motors shall be mounted according to manufacturer's recommendations. Two-speed motors shall have a single winding with variable torque characteristics.

2.14.14 Stairways and Ladders

Provide stairs, 60-degree ship ladders or straight-rung ladders of standard design, starting at [ground] [roof] level and extending as high as required to gain access to fan decks and water distribution systems. Stairways and ladders, shall be hot-dip, zinc-coated steel. Ladders higher than 12 feet shall have a safety cage.

2.14.15 Handrailings

Steel handrailings shall be not less than 42 inches high around the exterior of each working surface that is 12 feet or more above the ground, roof, or other supporting construction. Railings shall be not smaller than 1-1/4 inch zinc-coated steel pipe with standard zinc-coated steel railing.

2.14.16   Access Doors

Each tower shall be provided with access doors at grade level to provide entry to the interior for service maintenance without removal of the fill. Doors shall be provided on each endwall of each cooling tower cell. Frame and brace access doors to prevent damage when opening and closing. Locate doors adjacent to float controls.

2.15   WATER TREATMENT SYSTEMS

When water treatment is specified, the use of chemical-treatment products containing hexavalent chromium (Cr) is prohibited.

2.15.1   Water Analysis

****

NOTE: A water analysis may be available from the user. If an analysis is not available, an analysis will be performed during the design, and appropriate data will be entered.

****

Conditions of make-up water to be supplied to the condenser and chilled water systems were reported in accordance with ASTM D 596 and are as follows:

Date of Sample	[_____]
Temperature	[_____] degrees F
Silica (SiO2)	[_____] ppm (mg/1)
Insoluble	[_____] ppm (mg/1)
Iron and Aluminum Oxides	[_____] ppm (mg/1)
Calcium (Ca)	[_____] ppm (mg/1)
Magnesium (Mg)	[_____] ppm (mg/1)
Sodium and Potassium (Na and K)	[_____] ppm (mg/1)
Carbonate (HCO3)	[_____] ppm (mg/1)
Sulfate (SO4)	[_____] ppm (mg/1)
Chloride (Cl)	[_____] ppm (mg/1)
Nitrate (NO3)	[_____] ppm (mg/1)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] epm (meq/1)
Non-Carbonate Hardness	[_____] epm (meq/1)
Total Hardness	[_____] epm (meq/1)
Dissolved Solids	[_____] ppm (mg/1)
Fluorine	[_____] ppm (mg/1)
Conductivity	[_____] micrmho/cm

2.15.2   Chilled and Condenser Water

Water to be used in the chilled and condenser water systems shall be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.

2.15.3   Glycol Solution

****
NOTE: Delete this paragraph if a dry cooler is not specified. When a glycol system is used, the size of the HVAC systems should be corrected due to changes in specific heat and viscosity. ASHRAE's "HVAC Systems and Equipment Handbook" should be consulted for the appropriate calculation procedures. Ethylene glycol should be used for HVAC systems however, if the heat transfer media has the possibility of mixing with a potable water system, propylene glycol should be used. The required concentration should be entered based upon the anticipated ambient or operating temperature.
****

A [_____] percent concentration by volume of industrial grade [ethylene] [propylene] glycol shall be provided for the system. The glycol shall be tested in accordance with ASTM D 1384 with less than 0.5 mils penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicate based inhibitors shall not be used. The solution shall be compatible with pump seals, other elements of the system, and all water treatment chemicals used within the system.

2.15.4 Water Treatment Services

****
NOTE: The services of a water treatment company to treat a chilled water system should only be required if the makeup water available is of very poor quality.
****

The services of a company regularly engaged in the treatment of [condenser] [condenser and chilled] water systems shall be used to determine the correct chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company shall maintain the chemical treatment and provide all chemicals required for the [condenser] [condenser and chilled] water systems for a period of one year from the date of occupancy. The chemical treatment and services provided over the one year period shall meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Acid treatment and proprietary chemicals shall not be used.

2.15.5 Chilled Water System

****
NOTE: For dual temperature systems (chilled and heated water), coordinate the compatibility of the separate water treatment systems.
****

A shot feeder shall be provided on the chilled water piping as indicated. Size and capacity of feeder shall be based upon local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.15.6 Condenser Water

****

NOTE: Cooling towers with a capacity of greater than 176 kW (50 tons) will be provided with automatic chemical feed and blow down systems. Smaller towers will be provided with continuously activated systems. Indicate the location of the entire water treatment system. Delete all the information under this paragraph if a cooling tower is not used in the system.

****

The water treatment system shall be capable of [automatically] [continuously] feeding chemicals and bleeding the system to prevent corrosion, scale, and biological formations. [Automatic chemical feed systems shall automatically feed chemicals into the condenser water based on varying system conditions.] [Continuously chemical feed systems shall continuously feed chemicals into the condenser water at a constant rate. The system shall be initially set manually based on the water analysis of the make-up water.]

2.15.6.1 Chemical Feed Pump

One pump shall be provided for each chemical feed tank. The chemical feed pumps shall be positive displacement diaphragm type. The flow rate of the pumps shall be adjustable from 0 to 100 percent while in operation. The discharge pressure of pumps shall not be less than 1.5 times the line pressure at the point of connection. The pumps shall be provided with a pressure relief valve and a check valve mounted in the pump discharge.

2.15.6.2 Tanks

Two chemical tanks shall be provided. The tanks shall be constructed of [high density polyethylene] [stainless steel] with a hinged cover. The tanks shall have sufficient capacity to require recharging only once per 7 days during normal operation. A level indicating device shall be included with each tank. An electric agitator shall be provided for each tank.

2.15.6.3 Injection Assembly

An injection assembly shall be provided at each chemical injection point along the condenser water piping as indicated. The injection assemblies shall be constructed of stainless steel. The discharge of the assemblies shall extend to the centerline of the condenser water piping. Each assembly shall include a shut-off valve and check valve at the point of entrance into the condenser water line.

2.15.6.4 Water Meter

Water meters shall be provided with an electric contacting register and remote accumulative counter. The meter shall be installed within the make-up water line, as indicated.

2.15.6.5 Timers

Timers shall be of the automatic reset, adjustable type, and electrically operated. The timers shall be suitable for a 120 volt current. The timers shall be located within the water treatment control panel.

2.15.6.6 Water Treatment Control Panel

****
NOTE: The MAN-OFF-AUTO switch should be deleted for continuously fed systems. In areas where a panel could come in contact with the water treatment chemical, choose the stainless steel construction.
****

The control panel shall be a NEMA 12 enclosure suitable for surface mounting. The panel shall be constructed of [stainless steel] [steel] with a hinged door and lock. The panel shall contain a laminated plastic nameplate identifying each of the following functions:

(1) Main power switch and indicating light;
(2) MAN-OFF-AUTO selector switch;
(3) Indicating lamp for bleed-off valve;
(4) Indicating lamp for each chemical feed pump;
(5) Set point reading for each timer;

2.15.6.7 Chemical Piping

The piping and fittings shall be constructed of [schedule 80 PVC] [stainless steel] suitable for the water treatment chemicals.

2.15.6.8 Sequence of Operation

****
NOTE: Choose the first set of brackets for automatic chemical feed systems. Choose the second set of brackets for continuous chemical feed systems.
****

[The chemicals shall be added based upon sensing the make-up water flow rate and activating appropriate timers. A separate timer shall be provided for each chemical. The blow down shall be controlled based upon the make-up water flow rate and a separate timer.] [The system shall contain an adjustable valve for continuous blow down. The flow rate from the appropriate chemical tanks shall be manually set at the metering pump for continuous chemical feed.] The injection of the chemical required for biological control shall be controlled by a timer which can be manually set for proper chemical feed. All timer set points, blow down rates, and chemical pump flow rates shall be determined and set by the water treatment company.

2.15.6.9 Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided.

2.15.6.10 Bleed Line

****
NOTE: Delete the following paragraph on bleed lines if an automatic chemical system is chosen.

****

A bleed line with a flow valve of the needle-valve type sized for the flow requirement or fixed orifice shall be provided in the pump return to the tower. The bleed line shall be extended to the nearest drain for continuous discharge.

2.16 EXPANSION TANK

Tank shall be welded steel, constructed, tested and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of [125] [_____] psig and precharged to the minimum operating pressure. Tank shall have a replaceable diaphragm and be the captive air type. Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with an air charging valve. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

2.17 AIR SEPARATOR TANK

External air separation tank shall be steel, constructed, tested, and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of [125] [_____] psi.

2.18 PURGE SYSTEM

****

NOTE: Refrigeration systems which operate below atmospheric pressure (i.e., R-123 machines) will require a refrigerant purge piping system. Indicate the routing of purge piping on the drawings. Require the Contractor to delete the piping if a purge system is not required for the type of refrigeration system that is to be provided. Indicate that it will be the contractor's responsible to size the piping based upon the recommendations of the refrigeration system's manufacturer. Purge discharge piping may be connected to the pressure-relief piping on the equipment side of the piping's vibration isolators.

****

Refrigeration systems which operate at pressures below atmospheric pressure shall be provided with a purge system. Purge systems shall automatically remove air, water vapor, and non-condensible gases from the system's refrigerant. Purge systems shall condense, separate, and return all refrigerant back to the system. An oil separator shall be provided with the purge system if required by the manufacturer. Purge system shall not discharge to occupied areas, or create a potential hazard to personnel. Purge system shall include a purge pressure gauge, number of starts counter, and an elapsed time meter. Purge system shall include lights or an alarm which indicate excessive purge or an abnormal air leakage into the system.

2.19   REFRIGERANT LEAK DETECTOR

****

NOTE: Refrigerant leak detectors will be provided as required by the "System Application Requirements" in ASHRAE 15.

When a detector is required, the location will be indicated on the drawings. Detectors are best located between the refrigeration system and the room exhaust. Sampling points from a detector will be located a maximum of 18 inches above the finished floor since all commonly-used refrigerants are heavier than air

As a rule of thumb, the distance between any refrigeration system and a refrigerant sampling point shouldn't exceed 50 feet. In order to meet the recommended 50 foot distance, a mechanical room can be provided with either multiple detectors each with single sampling points or with one detector that has the capability of monitoring at multiple sampling points. If multiple sampling points are required, enter the number in the appropriate blank below.

Per ASHRAE 15, when a detector senses refrigerant it must activate an alarm and initiate the room ventilation system. In regards to alarms, as a minimum indicate that the detector will energize a light on or near the detector as well as a second light installed on the outside wall next to the mechanical room entrance. The exterior light will be provided with a sign that warns personnel entering the mechanical room of a refrigerant release and that a SCBA is required to enter. If applicable to the installation, include an audible alarm on the exterior of the mechanical room. Include the electrical design for the alarm system on the drawings.

As an additional item, ASHRAE 15 states that open-flame devices (i.e., boilers, etc.) cannot be installed in the same area as a refrigeration system, unless either combustion air for the open-flame device is ducted straight from outside to the device; or the alarm relay from the detector is used to automatically shutdown the combustion process in the event of refrigerant leakage. Indicate all applicable alarm controls on the drawings.

Delete the information in the last bracketed sentences if an EMCS is not applicable to the design.

****

Detector shall be the continuously-operating, halogen-specific type. Detector shall be appropriate for the refrigerant in use. Detector shall be specifically designed for area monitoring and shall include [a single sampling point] [_____ sampling points] installed where indicated. Detector design and construction shall be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector shall have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Detector shall be supplied factory-calibrated for the appropriate refrigerant. Detector shall be provided with an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant in use. The detector's relay shall be capable of initiating corresponding alarms and ventilation system as indicated on the drawings. Detector shall be provided with a failure relay output that energizes when the monitor detects a fault in its operation. [Detector shall be compatible with the facility's energy management and control system (EMCS). The EMCS shall be capable of generating an electronic log of the refrigerant level in the operating area, monitoring for detector malfunctions, and monitoring for any refrigerant alarm conditions.]

2.20 REFRIGERANT RELIEF VALVE/RUPTURE DISC ASSEMBLY

****

NOTE: ASHRAE 15 requires refrigeration systems to be protected with a pressure-relief device that will safely relieve pressure due to fire or other abnormal conditions. A relief valve/rupture disc assembly is the optimum solution. The rupture disc will provide visual indication of a release while also providing immediate shutoff once a safe pressure is achieved.

Designer will indicate on the drawings the location of each new relief valve/rupture disc assembly s well as the routing and size of corresponding pressure-relief piping. The routing and size of new pressure-relief piping will be per ASHRAE 15.

****

The assembly shall be a combination pressure relief valve and rupture disc designed for refrigerant usage. The assembly shall be in accordance with ASME BPV IX and ASHRAE 15. The assembly shall be provided with a pressure gauge assembly which will provide local indication if a rupture disc is broken. Rupture disc shall be the non-fragmenting type.

2.21 REFRIGERANT SIGNS

refrigerant signs shall be a medium-weight aluminum type with a baked enamel finish. Signs shall be suitable for indoor or outdoor service. Signs shall have a white background with red letters not less than 0.5 inches in height.

2.21.1 Installation Identification

Each new refrigeration system shall be provided with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name
b. Refrigerant number and amount of refrigerant.
c. The lubricant identity and amount.
d. Field test pressure applied.

2.21.2 Controls and Piping Identification

Refrigerant systems containing more than 110 lb of refrigerant shall be provided with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow [, the ventilation system,] and the refrigerant compressor.
b. Pressure limiting device.

2.22 INSULATION

2.22.1 Field Installed Insulation

Field installed insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.22.2 Factory Installed Insulation

Factory applied insulation shall be as specified for the equipment to be insulated except that refrigerant suction lines shall be insulated with unicellular plastic foam. Insulation shall comply with the fire hazard rating specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.23 HEAT RECOVERY DEVICES

2.23.1 Hot Air Reclaim

Unit shall be a heat recovery, factory-fabricated, draw-through, central station type air conditioner in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

2.23.2 Hot Water Reclaim

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NOTE: Indicate the size of the exchanger either as a percent of the total rated condenser load or as a percent of the superheated portion of the total rated condenser load. The refrigerant compressor head pressure control and the circulating pump can be deleted if inapplicable.
****

Unit shall be a double-wall, tube-within-tube heat exchanger type, complete with thermostatic control. Unit shall be constructed and refrigerant pressure/temperature rated in accordance with ASHRAE 15. Heat exchanger coil shall consist of an external refrigerant containing carbon steel tube and an internal, double-wall-in-metallic contact, convoluted, potable water containing copper tube. Cabinet shall be fabricated of zinc-protected steel and be internally insulated in coil space. The recovery device shall be provided with a refrigerant compressor head pressure control and a interlocked, potable water circulating pump. Pump and motor assembly shall be close-coupled, manufacturer's standard type with indicated head and capacity characteristics, and with brass, bronze, copper or stainless steel wetted parts. Pump shall be mounted [remotely] [integral] to the exchanger and be rated for [115] [208] [230] volt ac power supply.

2.24 TEMPERATURE CONTROLS

****

NOTE: This paragraph should only be included for packaged and self-contained unitary systems requiring controls (i.e. thermostats, duct modulation, SLDC, etc.) not covered by this specifications. In projects where this section of the specification is intended to produce control equipment for existing air-side systems, this paragraph will be rewritten to secure controls to match existing controls and to properly integrate the specified controls into the existing temperature control system.

A sequence of control, a schematic of controls, and a ladder diagram should be included on the drawings for each cooling tower fan, chilled water pump, condenser water pump, etc. in order to define the overall system operation.

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Temperature controls shall be [in accordance with Section 15950HEATING, VENTILATING AND AIR CONDITIONING HVAC CONTROL SYSTEMS] [fully coordinated with and integrated into the existing air-conditioning system].

2.25 DUCTWORK COMPONENTS

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NOTE: The appropriate pressure classification from SMACNA TAB HVAC Sys, including points of changes in pressure classification, will be noted on the drawings. Indicate pitch of ductwork, low spots in ductwork, and means of disposing of condensate, where applicable.

The use of flexible duct should be limited due to the inordinate pressure drop and corresponding fan energy consumption that it causes. The extent of flexible duct will be shown on the drawings. The designer should also ensure that the restrictions in these standards pertaining to the use of non-metallic materials in air distribution plenums are followed.

The flammability and combustibility of non-metallic duct materials is controlled by NFPA 90A, 90B, and 91. The extent of non-metallic duct that can be used should be shown on the drawings when these

standards limit its use.
****

2.25.1 Metal Ductwork

Every aspect of metal ductwork construction, including fittings and components, shall comply with SMACNA TAB HVAC Sys unless otherwise specified. Elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure Class 1/2, 1, and 2 inch w.g. ductwork shall meet the requirements of Seal Class C. Class 3 through 10 inch shall meet the requirements of Seal Class A. Sealants shall conform to fire hazard classification specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA TAB HVAC Sys. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar will not be acceptable.

2.25.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

2.25.1.2 Metallic Flexible Duct

Metallic type duct shall be single-ply [galvanized steel] [Type 316 stainless steel] [two-ply aluminum] [, self supporting to 8 foot spans]. Duct shall be of corrugated/interlocked, folded and knurled type seam construction, bendable without damage through 180 degrees with a throat radius equal to 1/2 duct diameter. Duct shall conform to UL 181 and shall be rated for positive or negative working pressure of 15 inches water gauge at 350 degrees F when duct is aluminum, and 650 degrees F when duct is galvanized steel or stainless steel.

2.25.1.3 Insulated Nonmetallic Flexible Duct Runouts

Flexible duct runouts shall be used only where indicated. Runouts shall not exceed 10 feet in length, shall be preinsulated, factory fabricated, and comply with NFPA 90A and UL 181. Either field or factory applied vapor barrier shall be provided. Where coil induction or high velocity units are supplied with vertical air inlets, a streamlined and vaned and mitered elbow transition piece shall be provided for connection to the flexible duct or hose. The last elbow to these units, other than the vertical air inlet type, shall be a die-stamped elbow and not a flexible connector. Insulated flexible connectors may be used as runouts. The insulation material surface shall not be exposed to the air stream.

2.25.1.4   General Service Duct Connectors

A flexible duct connector approximately 6 inches in width shall be provided where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL Bld Mat Dir.

2.25.2   Fibrous Glass Ductwork

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NOTE: Fibrous glass ducts will not be used in air-conditioning systems for medical facilities or in clean rooms with requirements equal to or exceeding Class 100. Refer to AFR 88-15 for use on Air Force projects.

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Fibrous glass ductwork may be provided in lieu of sheet metal ductwork except that fibrous glass ductwork will not be allowed in fan and equipment rooms, where subject to traffic or weather damage, for outside air intakes, for risers of more than two stories, in kitchen or fume exhaust ducts, to convey solids or corrosive gases, in concrete, for burial below grade, as casings or housings, or in systems used for life support systems. Fibrous glass ductwork, including all components, shall be fabricated in accordance with NAIMA AH115 where the velocity and the static pressure are within its scope. Where the velocity or static pressure exceeds these limits, the ductwork manufacturer shall certify that the ductwork is intended for the velocities and pressures to be encountered, and that the proposed installation meets all performance criteria specified herein for metal ductwork. Field or factory fabricated fibrous glass ductwork shall conform to UL 181, Class 1. [Duct wall penetrations,] transverse joints and longitudinal seams shall be sealed as instructed by the manufacturer by one of the methods prescribed by NAIMA AH115, where applicable, except that pressure sensitive tape shall not be used as a sealant. Items necessary for a complete installation shall be provided as specified for sheet metal duct systems.

2.25.3   Ductwork Insulation

Ductwork insulation and related materials shall conform to the requirements of Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.25.4   Ductwork Accessories

2.25.4.1   Duct Access Doors

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NOTE: Provide duct access doors at regular intervals to facilitate the cleaning of duct systems for applications requiring clean air supplies, such as hospitals, laboratories, electronics servicing and similar activities.

****

Access doors shall be provided in ductwork where indicated and at all air flow measuring devices, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown, shall conform to SMACNA TAB HVAC Sys. Access doors shall be provided upstream and downstream of air flow measuring primaries and heating and cooling coils. Doors shall be minimum 15 x 18 inches, unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Doors 24 x 24 inches or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be the insulated type.

2.25.4.2 Fire Dampers

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NOTE: Indicate the location of each fire damper. Provide dampers in accordance with NFPA 90A. Three-hour rated fire dampers must be specifically identified.

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Fire dampers shall be 1-1/2 hour fire rated unless otherwise indicated. Fire dampers shall conform to the requirements of NFPA 90A and UL 555. Fire dampers shall be automatic operating type and shall have a dynamic rating suitable for the maximum air velocity and pressure differential to which it will be subjected. Fire dampers shall be approved for the specific application and shall be installed according to their listing. Fire dampers shall be equipped with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, will not impair the operation of the damper. Sleeves or frames shall be equipped with perimeter mounting angles attached on both sides of the wall or floor opening. Ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies shall be constructed in conformance with UL Fire Resist Dir. Fire dampers shall be [curtain type with damper blades] [in the air stream] [out of the air stream] [or] [single blade type] [or] [multi-blade type]. Dampers shall not reduce the duct or the air transfer opening cross-sectional area. Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.25.4.3 Splitters and Manual Balancing Dampers

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NOTE: Indicate the location of all volume dampers. Diffuser and register volume dampers will not be used for balancing.

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Splitters and manual balancing dampers shall be furnished with accessible operating mechanisms. Where operators occur in finished portions of the building, operators shall be chromium plated with all exposed edges rounded. Splitters shall be operated by quadrant operators or 3/16 inch rod brought through the side of the duct with locking setscrew and bushing. Two rods are required on splitters over 8 inches. Manual volume control dampers shall be operated by locking-type quadrant operators. Dampers and splitters shall be 2 gauges heavier than the duct in which installed. Unless otherwise indicated, multileaf dampers shall be opposed blade type with maximum blade width of 12 inches. Access doors or panels shall be provided for all concealed damper operators and locking setscrews. Unless otherwise indicated, the locking-type quadrant operators for dampers, when installed on ducts to be thermally insulated, shall be provided with stand-off mounting brackets, bases, or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer. Volume dampers shall be provided where indicated.

2.25.4.4 Air Deflectors and Branch Connections

Air deflectors shall be provided at all duct mounted supply outlets, at all takeoff or extension collars to supply outlets, at all duct branch takeoff connections, and at all 90 degree elbows, as well as at all locations as indicated on the drawings or shown in the Sheet Metal and Air Contractors National Association manuals. Air deflectors, except those installed in 90 degree elbows, shall be provided with an approved means of adjustment. Adjustment shall be made from easily accessible means inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, external adjustments shall be provided with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Air deflectors shall be factory-fabricated units consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Air deflectors shall be factory or field assembled. Blade air deflectors, also called blade air extractors, shall be approved factory fabricated units consisting of equalizing grid and adjustable blade and lock. Adjustment shall be easily made from the face of the diffuser or by position adjustment and lock external to the duct. Stand-off brackets shall be provided on insulated ducts and are described herein before. Fixed air deflectors, also called turning vanes, shall be provided in all 90 degree elbows. Turning vanes shall be designed as shown in the Sheet Metal and Air Condition Contractors National Association manuals.

2.25.5 Duct Sleeves, Framed Prepared Openings, Closure Collars

2.25.5.1 Duct Sleeves

Duct sleeves shall be provided for all round ducts 15 inchesin diameter or less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round ducts larger than 15 inches in diameter and all square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 20 gauge galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53, Schedule 20 shall be used. Sleeve shall provide 1 inch clearance between the duct and the sleeve or 1 inch clearance between the insulation and the sleeve for insulated ducts.

2.25.5.2 Framed Prepared Openings

Openings shall have 1 inch clearance between the duct and the opening or 1 inch clearance between the insulation and the opening for insulated ducts.

2.25.5.3 Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 4 inches wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 15 inches in diameter or less shall be fabricated from 20 gauge galvanized steel. Collars for round ducts larger than 15 inches and all square, and rectangular ducts shall be fabricated from 18 gauge galvanized steel. Collars shall be installed with fasteners on maximum 6 inch centers, except that not less than 4 fasteners shall be used.

2.25.6 Sound Attenuation Equipment

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NOTE: Sound attenuators or acoustical duct liner will be used only where acoustical treatment is required and there are no other suitable alternatives. Acoustical duct liner will not be used in systems where the total pressure is above 4 inches water gauge in any portion of the air-conditioning system in medical facilities for Army construction. Refer to AFR 88-15 for use on Air Force projects.

Refer to TM 5-805-4, Noise and Vibration Control for Mechanical Equipment, for noise criteria. Sound power levels required should be included in the appropriate schedule on the drawings.

****

2.25.6.1 High Pressure Systems

Sound attenuators shall be provided on the discharge duct of each fan operating at a total pressure above 4 inches water gauge, and, when indicated, at the intake of each fan system. Sound attenuators shall be provided elsewhere as indicated. The sound attenuators shall be factory fabricated and shall be tested by an independent laboratory for sound and performance characteristics. Net sound reduction shall be as indicated. Maximum permissible pressure drop shall not exceed 0.63 inch water gauge. Traps shall be constructed to be airtight when operating under an internal static pressure of 10 inch water gauge. Air-side surface shall be capable of withstanding air velocity of 10,000 fpm. The Contractor shall certify that the sound reduction values specified will be obtained after the equipment is installed in the system and coordinated with the sound information of the system fan to be provided. Sound absorbing material shall conform to ASTM C 1071, Type I or II. Sound absorbing material shall meet the fire hazard rating requirements for insulation specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. A duct transition section shall be provided for connection to ductwork. Factory fabricated double-walled internally insulated spiral lock seam and round duct and fittings designed for high pressure air system may be provided in lieu of factory fabricated sound attenuators, and shall comply with all requirements specified for factory fabricated sound attenuators. The double-walled duct and fittings shall be constructed of an outer metal pressure shell of zinc-coated steel sheet, 1 inch thick acoustical blanket insulation, and an internal perforated zinc-coated metal liner. Sufficient length of run shall be provided to obtain the noise reduction coefficient specified. The Contractor shall certify that the sound reduction value specified will be obtained within the length of duct run provided. The outer sheet metal of the double-walled duct shall have welded, or spiral lock, seams to prevent water vapor penetration. The outer sheet of the duct and fittings shall conform to the metal thickness of high pressure spiral and round ducts and fittings shown in SMACNA TAB HVAC Sys. The acoustical insulation shall have a thermal conductivity "k" of not more than 0.27 Btu/inch/square foot/hour/degree F at 75 degrees F mean temperature. The internal perforated zinc-coated metal liner shall be not less than 24 gauge with perforations not larger than 1/4 inch in diameter providing a net open area not less than 10 percent of the surface.

2.25.6.2 Low Pressure Systems

Low pressure systems shall be defined as a system with a total pressure of 4 inches water gauge or lower. Sound attenuators shall be provided only where indicated, or in lieu of lined ducts. Factory fabricated sound attenuators shall be constructed of galvanized steel sheets. Outer casing shall be not less than 22 gauge. Acoustical fill shall be fibrous glass. Net sound reduction shall be as indicated. Values shall be obtained on a test unit not less than 24 inches by 24 inches outside dimensions made by a certified nationally recognized independent acoustical laboratory. Air flow capacity shall be as indicated or required. Pressure drop through the attenuator shall not exceed the value indicated, or shall not be in excess of 15 percent of the total external static pressure of the air handling system, whichever is less. Sound attenuators shall be acoustically tested with metal duct inlet and outlet sections while under the rated air flow conditions. Noise reduction data shall include the effects of flanking paths and vibration transmission. Sound attenuators shall be constructed to be airtight when operating at the internal static pressure indicated or specified for the duct system, but in no case less than 2 inch water gauge.

2.25.6.3 Acoustical Duct Liner

Acoustical duct lining shall be fibrous glass designed exclusively for lining ductwork and conform to the requirements of ASTM C 1071, Type I and II. Liner composition may be uniform density, graduated density, or dual density, as standard with the manufacturer. Lining shall be coated, not less than 1 inch thick, nominal, and where applicable be of sufficient thickness to be thermally equivalent to the thickness of insulation specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Duct sizes shown shall be increased to compensate for the thickness of the lining used. In lieu of sheet metal duct with field-applied acoustical lining, acoustically equivalent lengths of fibrous glass duct or factory fabricated double-walled internally insulated duct with perforated liner may be provided. Net insertion loss value, static pressure drop, and air flow velocity capacity data shall be certified by a nationally recognized independent acoustical laboratory.

2.25.7 Diffusers, Registers, and Grilles

****
NOTE: Coordinate with paragraph Sound Attenuation Equipment.

If diffusers or registers or grilles are not required, reference to the omitted items will be deleted. Specified performance characteristics peculiar to the omitted items will be deleted. If any one or two of the three types of units are omitted, the corresponding subparagraph will be deleted.
****

Units shall be factory-fabricated of steel, corrosion-resistant steel, or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified in accordance with ADC 1062:GRD. Inlets and outlets shall be sound rated and certified in accordance with ADC 1062:GRD. Sound power level shall be as indicated. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers, except linear slot diffusers. Linear slot diffusers shall be provided with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, they shall be protected by a grille or screen in accordance with NFPA 90A.

2.25.7.1 Diffusers

Diffuser types shall be as indicated. Ceiling mounted units shall be furnished with antismudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Diffusers shall be provided with air deflectors of the type indicated. Air handling troffers or combination light and ceiling diffusers shall conform to the requirements of UL Elec Const Dir for the interchangeable use as cooled or heated air supply diffusers or return air units. Ceiling mounted units shall be installed with rims tight against ceiling. Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller. Return or exhaust units shall be similar to supply diffusers.

2.25.7.2 Registers and Grilles

Units shall be four-way directional-control type, except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 6 inches below the ceiling unless otherwise indicated. Return and exhaust registers shall be located 6 inches above the floor unless otherwise indicated. Four-way directional control may be achieved by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Grilles shall be as specified for registers, without volume control damper.

2.25.8 Louvers

Louvers shall be furnished for installation in exterior walls which are directly connected by ductwork to air handling equipment. Louver blades shall be fabricated from anodized aluminum or galvanized steel sheets, and shall be provided with a frame of galvanized steel or aluminum structural shapes. Sheet metal thickness and fabrication shall conform to SMACNA TAB HVAC Sys. Blades shall be accurately fitted and secured to frames. Edges of louver blades shall be folded or beaded for rigidity and baffled to exclude driving rain. Louver shall be provided with bird screen. Louvers shall bear AMCA Certified Ratings Seal for air performance and water penetration ratings as described in AMCA Std 500.

2.26 CONDENSER WATER PIPING

2.26.1 Steel Pipe

Steel pipe shall conform to ASTM A 53, Schedule 40, Type E or S, Grades A or B. Type F pipe shall not be used.

2.26.2 Joints and Fittings, Steel Pipe

Joints and fittings shall be welded, flanged, threaded, or grooved as indicated. If not otherwise indicated, piping 1 inch and smaller shall be threaded; piping larger than 1 inch and smaller than 3 inches shall be either threaded, grooved, or welded; and piping 3 inches and larger shall be grooved, welded, or flanged. Rigid grooved mechanical joints and fittings may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 230 degrees F. Flexible grooved joints shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein. The manufacturer of each fitting shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

2.26.2.1 Welded

Welded fittings shall conform to ASTM A 234/A 234M, and identified with the appropriate grade and marking symbol. Butt-welding fittings shall conform to ASME B16.9. Socket-welding and threaded fittings shall conform to ASME B16.11.

2.26.2.2 Flanged

Flanges shall conform to ASTM A 181/A 181M and ASME B16.5 Class 150. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. This gaskets shall contain aramid fibers bonded with styrene butadine rubber (SBR) or nitrile butadine rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.5. Bolts shall be high or intermediate strength material conforming to ASTM A 193/A 193M.

2.26.2.3 Threaded

Threads shall conform to ASME B1.20.1. Pipe nipples shall conform to ASTM A 733, type and material to match adjacent piping. Unions shall conform to ASME B16.39, type as required to match adjacent piping.

2.26.2.4   Dielectric Unions and Flanges

Dielectric unions shall have the tensile strength and dimensional requirements specified. Unions shall have metal connections on both ends threaded to match adjacent piping. Metal parts of dielectric unions shall be separated with a nylon insulator to prevent current flow between dissimilar metals. Unions shall be suitable for the required operating pressures and temperatures. Dielectric flanges shall provide the same pressure ratings as standard flanges and provide complete electrical isolation.

2.26.2.5   Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 125 psi service and shall the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47,ASTM A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming ASTM A 106, Grade B or ASTM A 53. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 230 degrees F or Grade No. M3BA610A15B44Z for circulating medium up to 200 degrees F. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

2.26.3   Copper Tube

Copper tubing for water service shall conform to ASTM B 88, ASTM B 88M, Type K or L.

2.26.4   Joints and Fittings, Copper Tube

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.26.5   Valves

Valves shall be Class 125 and shall be suitable for the intended application. Valves shall meet the material, fabrication and operating requirements of ASME B31.1. Chain operators shall be provided for valves located 10 feet or higher above the floor.

2.26.5.1   Gate Valves

Gate valves 2-1/2 inch and smaller shall conform to MSS SP-80 and shall be bronze with rising stem and threaded, soldered, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70, Type I, II, Class 125, Design OF and shall be cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.26.5.2   Globe and Angle Valves

Globe valves 2-1/2 inch and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Globe valves 3 inches and larger shall conform to MSS SP-85and shall be cast iron with bronze trim and flanged or threaded ends.

2.26.5.3 Check Valves

Check valves 2-1/2 inch and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Check valves 3 inches and larger shall conform to MSS SP-71, Type I, II, III, or IV, Class 125 or 150 and shall be cast iron with bronze trim and flanged or threaded ends.

2.26.5.4 Plug Valves

Tapered type valves, with a positive pressure sealant system providing for direct application of unseating pressure to the smaller end of the plug in all operating positions shall be used. Sealant grooves shall be arranged so as to completely surround the ports with the plug in the closed position and to prevent bypassing of sealant pressure to the line fluid passages in any position of the plug.

2.26.5.5 Ball Valves

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NOTE: Ball valves should be used only for drain valves or in makeup waterlines.
****

Ball valves 1/2 inch and larger shall conform to MSS SP-72 or MSS SP-110 and shall be ductile iron or bronze with threaded, soldered, or flanged ends.

2.26.5.6 Butterfly Valves

Butterfly valves shall be in accordance with MSS SP-67, Type 1 and shall be 2 flange or lug wafer type, and shall be bubble tight at 150 psi. Valve bodies shall be cast iron, malleable iron, or steel. Valves smaller than 8 inches shall have throttling handles with a minimum of seven locking positions. Valves 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

2.26.5.7 Manual Balancing Valves

Manual balancing valves, plug or ball type, shall conform to MSS SP-78. Valves 2 inches or smaller shall be bonze with NPT connections for black steel pipe and brazed connections for copper tubing. Valves 1 inch or larger shall be iron with threaded or flanged ends. Valves shall have a square head or similar device, an indicator arc, and be designed for 250 degrees F. Iron valves shall be lubricated, nonlubricated, or tetrafluoroethylene resin-coated plug or ball valves. Manual balancing valves 8 inches or larger shall be provided with manual gear operators with position indicators.

2.26.5.8 Calibrated Balancing Valves

Calibrated balancing valves shall have an integral pointer which registers the degree of valve opening or a lockable memory stop. Valves shall be calibrated so that flow can be determined when valve opening in degrees and pressure differential across the valve is known. Each balancing valve shall be constructed with internal seals to prevent leakage and be supplied with preformed insulation. Valves shall be suitable for 250 degrees F temperature and for 125 psi or 150 percent of the system operating pressure, whichever is greater. Where flow readings are provided by remote or portable meters, valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of the pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential across the valve. One portable flow meter, suitable for the operating pressure specified, shall be provided complete with hoses, vent, shutoff valves, and carrying case as recommended by the valve manufacturer.

2.26.5.9 Automatic Flow Control Valves

Automatic flow control valves shall maintain flow within 5 percent of the indicated flow rate when the inlet pressure is within the design range. A permanent nameplate or tags shall be attached to the valve that indicates the factory-determined flow rate and corresponding inlet pressure levels. the valves shall be suitable for 125 psi or 150 percent of the system operating pressure, whichever is greater. The design pressure differential for each valve shall be [2] [5] [_____] psi. Where flow readings are provided by remote or portable meters, valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of the pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential across the valve. Automatic flow control valves may be substituted for venturi tubes or orifice plate flow measuring devices. One portable flow meter, suitable for the operating pressure specified, shall be provided complete with hosed, vent, shutoff valves, and carrying case as recommended by the valve manufacturer.

2.26.6 Accessories

2.26.6.1 Air Vents

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NOTE: Indicate the location of each air vent. Distinguish between manual and automatic air vents.

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Manual air vents shall be brass or bronze valves or cocks suitable for 125 psi service, and furnished with threaded plugs or caps. Automatic air vents shall be float type, cast iron, stainless steel, or forged steel construction, suitable for 125 psi service.

2.26.6.2 Strainers

Basket and "Y" type strainers shall be the same size as the pipelines in which they are installed. The strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. Strainers shall be designed for [_____] psi and [_____] degrees F operating conditions. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with removable cover and sediment screen. The screen shall be made of 22 gauge [brass sheet,] [monel,] [corrosion-resistant steel,] with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.26.6.3   Combination Strainer and Suction Diffuser

A combination strainer and suction diffuser, consisting of an angle type body with removable strainer basket and straightening vanes, a suction pipe support, and a blowdown outlet, shall be provided on pump suction. The combination strainer and suction diffuser shall be designed for [_____] psi and [_____] degrees F operating conditions.

2.26.6.4   Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 125 psi or 150 psi service as appropriate for the static head plus the system head, and 250 degrees F, 230 degrees F for grooved end flexible connectors. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. The flexible section shall be suitable for intended service with end connections to match adjacent piping. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

2.26.6.5   Pipe Nipples

Pipe nipples shall be in accordance with ASTM A 733 and be of material to match adjacent piping.

2.26.6.6   Pipe Unions

Pipe unions shall be in accordance with ASME B16.39 and be of material to match adjacent piping.

2.26.6.7   Solder

Solder for water piping shall be in accordance with ASTM B 32, alloy grade 50B. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B 813.

2.26.7   Expansion Joints

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NOTE: Expansion loops, offsets, and bends will be used where possible instead of expansion joints and be located in serviceable areas. Expansion joints may only be installed on water piping.

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2.26.7.1   Slip-Tube Joints

Expansion joints shall provide for either single or double slip of the connected pipes, as required or indicated, and for not less than the traverse indicated. The joints shall be designed for working temperature and pressure suitable for the application, but not less than 150 psi, and shall be in accordance with applicable requirements of EJMA Stds and ASME B31.1. End connections shall be flanged or beveled for welding as indicated. Joints shall be provided with an anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip shall be seamless steel plated with a minimum of 5 mils of hard chrome in accordance with ASTM B 650. Joint components shall be suitable for the intended service. Initial settings shall be made in accordance with the manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer. Pipe alignment guides shall in no case be more than 5 feet from expansion joints except for pipe 4 inches or smaller. Pipe alignment guides on pipe 4 inches or smaller shall be installed not more than 2 feet from expansion joints. Service outlets shall be provided where indicated.

2.26.7.2 Flexible Ball Joints

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NOTE: The ball joint only moves in an angular offset or rotation mode. The configuration of the ball joint link will require a 2 or 3 ball joint offset to absorb axial and/or lateral movement.

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Flexible ball joints shall be constructed of alloys as appropriate for the service intended. Where so indicated, the ball joint shall be designed for packing injection under full line pressure to contain leakage. The joint ends shall be threaded [to 2 inches only], grooved, flanged, or beveled for welding as indicated or required and shall be capable of absorbing a minimum of 15 degree angular flex and 360 degree rotation. Ball and sockets shall be suitable for the intended service. The exterior spherical surface of carbon steel balls shall be plated with 5 mils of hard chrome in accordance with EJMA Stds and ASME B31.1 where applicable. Where required, flanges shall conform to ASME B16.5.

2.26.7.3 Bellows Type Joints

Bellows type joints shall be flexible, guided expansion joints. The expansion element shall be stabilized corrosion resistant steel. Bellows type expansion joints shall conform to the applicable requirements of EJMA Stds and ASME B31.1 with internal sleeves. Guiding of piping on both sides of expansion joint shall be in accordance with the published recommendations of the manufacturer of the expansion joint. The joints shall be designed for the working temperature and pressure suitable for the application but not less than 150 psi.

2.27 REFRIGERANT PIPING

Refrigerant piping, valves, fittings, and accessories shall conform to the requirements of ASHRAE 15 and ASME B31.5, except as specified.

2.27.1 Steel Pipe

Steel pipe for refrigerant service shall conform to ASTM A 53, Schedule 40, Type E or S, Grades A or B. Type F pipe shall not be used.

2.27.2 Joints and Fittings, Steel Pipe

Joints and fittings shall be steel butt-welding, socket-welding, or malleable iron threaded type. Pipe shall be welded except that joints on lines 2 inches and smaller may be threaded. Threads shall be tapered type conforming to ASME B1.20.1. The malleable iron threaded type fitting shall be of a weight corresponding to adjacent pipe. Flanges and flange faces of fittings shall be tongue-and-groove type with gaskets suitable for the refrigerant used; size 1 inch and smaller shall be oval, two-bolt type; size above 1 inch, up to and including 4 inches, shall be square four-bolt type; and sizes over 4 inches shall be round.

2.27.3 Steel Tubing

Steel tubing for refrigeration service shall be in accordance with ASTM A 334/A 334M, Grade 1. Tubing with a nominal diameter of 3/8 inch or 1/2 inch shall have a wall thickness of 0.049 inches. Tubing with a nominal diameter of 3/4 inch through 2 inches shall have a wall thickness of 0.065 inches. Tubing with a nominal diameter of 2 1/2 inches through 4 inches shall have a wall thickness of 0.095 inches. Steel tubing shall be cold-rolled, electric-forged, welded-steel. One end of the tubing shall be provided with a socket. Steel tubing shall be cleaned, dehydrated, and capped.

2.27.4 Joints and Fittings, Steel Tubing

Joints and fittings shall be socket type provided by the steel tubing manufacturer.

2.27.5 Copper Tubing

Copper tubing shall conform to ASTM B 280 annealed or hard drawn as required. Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing shall not be used in sizes larger than 1-3/8 inches. Joints shall be brazed except that joints on lines 7/8 inchand smaller may be flared.

2.27.6 Joints and Fittings, Copper Tubing

Copper tube joints and fittings shall be flare joint type with short-shank flare, or solder-joint pressure type. Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings shall not be allowed for brazed joints.

2.27.7 Valves

Valves shall be pressure and temperature rated for contained refrigerant service and shall comply with ASME B31.5. Metals of construction shall be ferrous or copper based. Atmosphere exposed valve stems shall be stainless steel or corrosion resistant metal plated carbon steel. Valve body connections shall be brazed or welded socket, flanged or combination thereof. Threaded connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Valves shall be suitable for or fitted with extended copper ends for brazing in-place without disassembly. Ferrous body valves shall be fitted with factory fabricated and brazed copper transitions. To minimize system pressure drops, where practicable, globe valves shall be angle body type, and straight line valves shall be full port ball type. Control valve inlets shall be fitted with integral or adapted strainer or filter where recommended or required by manufacturer. Valves shall be cleaned and sealed moisture-tight.

2.27.7.1 Refrigerant-Stop Valves

Valves, in sizes through 5/8 inch, shall be handwheel operated, straight or angle, packless diaphragm globe type with back-seating stem, brazed ends, except where SAE flare or retained seal cap connections are required. In sizes over 5/8 inch, valves shall be globe or angle type, wrench operated with ground-finish stems, or ball valves, packed especially for refrigerant service, back seated, and provided with seal caps. Refrigerant isolation and shut-off valves shall have retained or captive spindles and facilities for tightening or replacement of the gland packing under line pressure as applicable. Stop valves shall have back-seating plated steel stem, bolted bonnet in sizes 1-1/8 inches OD and larger, integral or flanged transition brazed socket. Valves in sizes through 2-1/2 inches shall be end-entry body assembly, full-port, floating ball type, with equalizing orifice fitted chrome plated ball, seats and seals of tetrafluoroethylene, chrome plated or stainless steel stem, and seal cap. In sizes 4 inch IPS and larger, and in smaller sizes where carbon steel piping is used, valve bodies shall be tongue and groove flanged and complete with mating flange, gaskets and bolting for socket or butt-weld connection. Purge, charge and receiver valves shall be of manufacturer's standard configuration.

2.27.7.2 Check Valves

Valve shall be designed for service application, spring-loaded type where required, with resilient seat and with flanged body in sizes 1/2 inch and larger. Valve shall provide positive shut-off at [1-1/2] [2] [3] psi differential pressure.

2.27.7.3 Liquid Solenoid Valves

Valves shall comply with ARI 760 and be suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves shall be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions shall be furnished. Solenoid coils shall be moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves shall have safe working pressure of 400 psi and a maximum operating pressure differential of at least 200 psi at 85 percent rated voltage. Valves shall have an operating pressure differential suitable for the refrigerant used.

2.27.7.4 Expansion Valves

Expansion valves conform to requirements of ARI 750. Valve shall be of the diaphragm and spring type with internal or external equalizers, and bulb and capillary tubing. Valve shall be provided with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 2 degrees F of saturated suction temperature at evaporator conditions. Bulb charge shall be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Gas limited liquid charged valves and other valve devices for limiting evaporator pressure shall not be used without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves shall have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. An isolatable pressure gauge shall be provided in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicated or for constant evaporator loads.

2.27.7.5 Safety Relief Valve

Valve shall be the two-way type. Single type valves shall be used only where indicated. Valve shall bear the ASME code symbol. Valve capacity shall be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve shall be of an automatically reseating design after activation.

2.27.7.6 Evaporator Pressure Regulators, Direct-Acting

Valve shall include a diaphragm/spring power assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve shall maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load shall not exceed the pressure difference corresponding to a 2 degrees F change in saturated refrigerant temperature at evaporator operating suction temperature. Spring shall be selected for indicated maximum allowable suction pressure range.

2.27.7.7 Refrigerant Access Valves

Refrigerant access valves and hose connections shall be in accordance with ARI 720.

2.27.8 Accessories

2.27.8.1 Filter Driers

Driers shall conform to ARI 710. Sizes 5/8 inch and larger shall be the full flow, replaceable core type. Sizes 1/2 inch and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 1,500 psi.

2.27.8.2 Sight Glass and Liquid Level Indicator

a. Assembly and Components: Assembly shall be pressure- and temperature-rated and constructed of materials suitable for the service. Glass shall be borosilicate type. Ferrous components subject to condensation shall be electro-galvanized.

b. Gauge Glass: Gauge glass shall include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

c. Bull's-Eye and Inline Sight Glass Reflex Lens: Bull's-eye and inline sight glass reflex lens shall be provided for dead-end liquid service. For pipe line mounting, two plain lenses in one body suitable for backlighted viewing shall be provided.

d. Moisture Indicator: Indicator shall be a self-reversible action, moisture reactive, color changing media. Indicator shall be furnished with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator shall be an integral part of each corresponding sight glass.

2.27.8.3 Vibration Dampeners

Dampeners shall be of the all-metallic bellows and woven-wire type.

2.27.8.4 Flexible Pipe Connectors

Connector shall be pressure and temperature rated for the service in accordance with ASHRAE 15 and ASME B31.5. Connector shall be a composite of interior corrugated phosphor bronze or Type 300 Series Stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Assembly shall be constructed with a safety factor of not less than 4 at 300 degrees F. Unless otherwise indicated, the length of a flexible connector shall be as recommended by the manufacturer for the service intended.

2.27.8.5 Strainers

Strainers used in refrigerant service shall have brass or cast iron body, Y-or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe diameter with pressure rating compatible with the refrigerant service. Screens shall be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

2.27.8.6 Brazing Materials

Brazing materials for refrigerant piping shall be in accordance with AWS A5.8, Classification BCuP-5.

2.28 DRAIN AND MISCELLANEOUS PIPING

Piping, fittings, valves and accessories for drain and miscellaneous services shall be in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

2.29 FABRICATION

2.29.1 Factory Coating

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NOTE: A salt fog test should be required for all outdoor equipment. Specify a 125-hour test in noncorrosive environments and a 500-hour test in a corrosive environments.

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Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand [125] [500] hours exposure to the salt spray test specified in ASTM B 117 using a 25 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

2.29.2 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09900PAINTING, GENERAL.

2.29.2.1 Color Coding

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NOTE: Color coding for piping identification required by the using agency will be developed and inserted in the "Color Code Schedule" in Section 09900 PAINTING, GENERAL. For Air Force Installations, piping will be color-coded in accordance with Attachment 4 of AFM 88-15.

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Color coding for piping identification is specified in Section 09900 PAINTING, GENERAL.

2.29.2.2 Color Coding Scheme

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NOTE: Color Coding Scheme may be deleted in accordance with Notes in Section 15400 PLUMBING, GENERAL PURPOSE.

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A color coding scheme for locating hidden piping shall be in accordance with [Section 15400 PLUMBING, GENERAL PURPOSE] [Section 15405PLUMBING, HOSPITAL].

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPV VIII Div 1 and ASME BPV IX, the design, fabrication, and installation of the system shall conform to ASME BPV VIII Div 1 and ASME BPV IX.

3.1.1 Equipment

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NOTE: Determine in the initial stages of design the approximate distances required for maintenance clearances of all new equipment. The maintenance clearances will be used in determining the final layout of the equipment. For installations where noise and vibration transmission to the building must be reduced, the maximum tolerable transmissibility, in percent, should be determined

and the blank filled in with appropriate value. When it is not necessary to specify the percent of transmissibility, the item in the brackets will be deleted and brackets removed. Recommended transmissibility in percentages are: 10 percent for equipment mounted in very critical areas; 10 to 20 percent for critical areas; and 20 to 40 percent for noncritical areas. The drawings should be checked to ensure that all structural and equipment connection factors and the conditions surrounding the equipment to be provided with the vibration isolation units favorably influence the effectiveness of the isolators. Where many items of equipment require different transmission values, based on the equipment location, the specification may be revised to indicate the appropriate values on the drawings.

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Refrigeration equipment and the installation thereof shall conform to ASHRAE 15. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, and similar items. Compressors shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be provided. Each foundation shall include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment shall be set on not less than a 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps shall have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block shall be of mass not less than three times the combined pump, motor, and base weights. Isolators shall be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Lines connected to pumps mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.1.2 Mechanical Room Ventilation

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For mechanical rooms which are intended to house refrigeration equipment, designers will use ASHRAE 15 to determine applicable design criteria. Delete this paragraph if a mechanical room is not applicable to the design.

In summary, ASHRAE 15 allows the use of either natural or mechanical ventilation systems, however, natural ventilation is allowed only in certain

limited applications. Natural ventilation is allowed only when "a refrigerant system is located outdoors more than 6.1 m (20 ft) from building openings and is enclosed by a penthouse, lean-to or other open structure", otherwise mechanical ventilation is required.

The amount of ventilation air required for a mechanical room will be determined based upon the ventilation equations in ASHRAE 15. In order to use these equations, a designer must approximate the mass of refrigerant (kgs or lbs) expected in the largest system located in the mechanical room.

Refrigerant quantities will be determined based upon a minimum of 2 different system manufacturers.

a. For a natural ventilation system, ASHRAE 15 provides an equation for sizing the amount of free opening area required.

b. For a mechanical ventilation system, ASHRAE 15 requires both normal and alarm ventilation. Normal ventilation will be sized to cover personnel ventilation requirements (2.5 1/s/m2 or 0.5 cfm/ft2) and heat buildup requirements if applicable. Alarm ventilation will be sized based upon the equations in ASHRAE 15. Both the normal and alarm ventilation rates can be achieved using the same ventilation system (e.g., multi-speed exhaust fans), however, individual systems are preferred. For the alarm ventilation, exhaust intakes will be located near the equipment and close to the finished floor. Most commonly used refrigerants are heavier-than-air and subsequently sink to the floor. Also per ASHRAE 15, air supply and exhaust ducts to the mechanical room will serve no other area within a facility. Discharge air from a mechanical ventilation system will be to the outdoors.
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Mechanical ventilation systems shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

3.1.3 Building Surface Penetrations

Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A 653/A 653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A 53, [Schedule 30] [Schedule 20] [Standard weight]. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

3.1.3.1 Refrigerated Space

Refrigerated space building surface penetrations shall be fitted with sleeves fabricated from hand-lay-up or helically wound, fibrous glass reinforced polyester or epoxy resin with a minimum thickness equal to equivalent size Schedule 40 steel pipe. Sleeves shall be constructed with integral collar or cold side shall be fitted with a bonded slip-on flange or extended collar. In the case of masonry penetrations where sleeve is not cast-in, voids shall be filled with latex mixed mortar cast to shape of sleeve and flange/external collar type sleeve shall be assembled with butyl elastomer vapor barrier sealant through penetration to cold side surface vapor barrier overlap and fastened to surface with masonry anchors. Integral cast-in collar type sleeve shall be flashed [as indicated.] [with not less than 4 inches of cold side vapor barrier overlap of sleeve surface.] Normally noninsulated penetrating round surfaces shall be sealed to sleeve bore with mechanically expandable seals in vapor tight manner and remaining warm and cold side sleeve depth shall be insulated with not less than [4] [_____] inches of foamed-in-place rigid polyurethane or foamed-in-place silicone elastomer. Vapor barrier sealant shall be applied to finish warm side insulation surface. Warm side of penetrating surface shall be insulated beyond vapor barrier sealed sleeve insulation for a distance which prevents condensation. Wires in refrigerated space surface penetrating conduit shall be sealed with vapor barrier plugs or compound to prevent moisture migration through conduit and condensation therein.

3.1.3.2 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07900 JOINT SEALING.

3.1.3.3 Waterproof Penetrations

Pipes passing through roof or floor waterproofing membrane shall be installed through a 17-ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8 inches from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2 inches above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

a. Waterproofing Clamping Flange: Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3.1.3.4 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07840 FIRESTOPPING.

3.1.3.5 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

3.1.4 Access Panels

Access panels shall be provided for all concealed valves vents, controls, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METALS.

3.1.5 General Piping Installation

3.1.5.1 Brazed Joints

Brazing shall be performed in accordance with AWS Brazing Hdbk, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Joints in steel tubing shall be painted with the same material as the baked-on coating within 8 hours after joints are made. Tubing shall be protected against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Piping shall be supported prior to brazing and not be sprung or forced.

3.1.5.2 Threaded Joints

Threaded joints shall be made with tapered threads and made tight with PTFE tape complying with ASTM D 3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

3.1.5.3 Welded Joints

Welded joints in steel refrigerant piping shall be fusion-welded. Changes in direction of piping shall be made with welded fittings only; mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. Branch connections shall be made with welding tees or forged welding branch outlets. Steel pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1 or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.5.4 Flanged Joints

Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for use with the refrigerants to be handled. When steel refrigerant piping is used, union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment requiring maintenance, such as compressors, coils, refrigeration equipment, control valves, and other similar items.

3.1.5.5 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.6 Condenser Water Piping

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

3.1.6.1 Directional Changes

Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

3.1.6.2 Functional Requirements

Horizontal supply mains shall pitch down in the direction of flow as indicated. The grade shall not be less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the system. Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 2-1/2 inches or less in diameter, and with flanges for pipe 3 inches or more in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric unions or flanges. Piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded.

3.1.6.3 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

3.1.6.4 Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

3.1.6.5 Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps [or plugged tees] unless otherwise indicated.

3.1.6.6 Flexible Pipe Connectors

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NOTE: Flexible pipe connectors will be provided where required to absorb expansion and contraction, isolate vibration, absorb noise, compensate offset motion, absorb continuous flexing, and relieve equipment from piping stresses. Where flexible pipe connectors are needed to correct lateral, parallel, and angular misalignment, their use will be limited to maximum offset as recommended, in writing, by the manufacturer. Flexible pipe connectors will only be used on water piping.

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Preinsulated flexible pipe connectors shall be attached to other components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the flexible pipe connector manufacturer and shall be provided at the intervals recommended.

3.1.7 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

3.1.7.1 Grooved Mechanical Joints

Grooves shall be prepared in accordance with the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances.

3.1.8 Refrigeration Piping

Unless otherwise specified, pipe and fittings installation shall conform to requirements of ASME B31.5. Pipe shall be cut accurately to measurement established at the jobsite and worked into place without springing or forcing. Cutting or otherwise weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipes shall be cut square, shall have burrs removed by reaming, and shall be installed in a manner to permit free expansion and contraction without damage to joints or hangers. Filings, dust, or dirt shall be wiped from interior of pipe before connections are made.

3.1.8.1 Directional Changes

Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide-sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, or other malformations will not be accepted.

3.1.8.2 Functional Requirements

Piping shall be installed 1/2 inch per 10 feet of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings.

3.1.8.3 Manual Valves

Stop valves shall be installed on each side of each piece of equipment such as compressors, condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Angle and globe valves shall be installed with stems horizontal unless otherwise indicated. Ball valves shall be installed with stems positioned to facilitate operation and maintenance. Isolating valves for pressure gauges and switches shall be external to thermal insulation. Safety switches shall not be fitted with isolation valves. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 1 inch.Filter dryers having access ports may be considered a point of isolation. Purge valves shall be provided at all points of systems where accumulated noncondensible gases would prevent proper system operation. Valves shall be furnished to match line size, unless otherwise indicated or approved.

3.1.8.4 Expansion Valves

Expansion valves shall be installed with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 2-1/8 inches in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 2-1/8 inches. The bulb shall be securely fastened with two clamps. The bulb shall be insulated. The bulb shall installed in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing shall be facing up.

3.1.8.5 Valve Identification

Each system valve, including those which are part of a factory assembly, shall be tagged. Tags shall be in alphanumeric sequence, progressing in direction of fluid flow. Tags shall be embossed, engraved, or stamped plastic or nonferrous metal of various shapes, sized approximately 1-3/8 inch diameter, or equivalent dimension, substantially attached to a component or immediately adjacent thereto. Tags shall be attached with nonferrous, heavy duty, bead or link chain, 14 gauge annealed wire, nylon cable bands or as approved. Tag numbers shall be referenced in Operation and Maintenance Manuals and system diagrams.

3.1.8.6 Vibration Dampers

Vibration damper shall be provided in the suction and discharge lines on spring mounted compressors. Vibration dampers shall be installed parallel with the shaft of the compressor and be anchored firmly at the upstream end on the suction line and the downstream end in the discharge line.

3.1.8.7 Strainers

Strainers shall be provided immediately ahead of solenoid valves and expansion devices and where indicated. Strainers may be an integral part of the expansion valve.

3.1.8.8 Filter Dryer

A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Dryers shall be sized in accordance with the manufacturers recommendations. A dryer shall be installed such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

3.1.8.9 Sight Glass

A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of filter dryers and where indicated. Sight glass shall be full line size.

3.1.8.10 Flexible Connectors

Flexible metallic connectors shall be installed perpendicular to line of motion being isolated. Piping for equipment with bidirectional motion shall be fitted with two flexible connectors, in perpendicular planes. Reinforced elastomer flexible connectors shall be installed in accordance with manufacturer's instructions. Piping guides and restraints related to flexible connectors shall be provided as required.

3.1.9 Thermometers

Thermometers located within 5 feet of floor may be rigid stem type. Where thermal well is located above 5 feet above floor, thermometer shall be universal adjustable angle type or remote element type to 7 feet above floor and remote element type where thermal well is 7 feet or more above floor. Thermometers shall be located in coolant supply and return or waste lines at each heat exchanger, condenser water lines entering and leaving the condenser, at each automatic temperature control device without an integral thermometer, refrigerant liquid line leaving receiver, refrigerant suction line at each evaporator or liquid cooler, and where indicated or required for proper operation of equipment.

3.1.10 Piping Supports

Refrigerant pipe supports shall be in accordance with ASME B31.5. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.10.1 Seismic Requirements

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NOTE: Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record and show on drawings. Delete the bracketed phrase if no seismic requirements are provided. Sections 13080 and 15070, properly edited, must be included in the contract documents.

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Piping and attached valves shall be supported and braced to resist seismic loads as specified under Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT [as indicated]. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05210 STRUCTURAL STEEL.

3.1.10.2 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Material used for support shall be as specified under Section 05210 STRUCTURAL STEEL.

3.1.11 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used.

3.1.11.1   Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.1.11.2   Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.1.11.3   C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.1.11.4   Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

3.1.11.5   Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

3.1.11.6   Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. [Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.]

3.1.11.7   Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feetfrom end of risers, and at vent terminations.

3.1.11.8   Pipe Guides

Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.1.11.9   Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle shall be used. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.11.10 High Temperature Guides with Cradles

Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.

3.1.11.11 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.12 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.1.13 Pipe Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal. Detailed drawings of pipe anchors shall be submitted for approval before installation.

3.1.14 Piping Identification

Each piping system and direction of fluid flow shall be identified in accordance with applicable provisions of ANSI A13.1 with color coded, water, moisture and broad-spectrum temperature resistant, plastic labels.

3.1.15 Metal Ductwork

Installation shall be in accordance with SMACNA TAB HVAC Sys unless otherwise indicated. Duct supports for sheet metal ductwork shall be in accordance with SMACNA TAB HVAC Sys, unless otherwise specified. Friction beam clamps indicated in SMACNA TAB HVAC Sys will not be used. [Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion.] Supports on the risers shall allow free vertical movement of the duct. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

3.1.16 Fibrous Glass Ductwork

Installation shall be in accordance with the manufacturer's written recommendations unless otherwise required in NAIMA AH115. Duct supports for fibrous glass ductwork shall conform to NAIMA AH115. In those cases not covered in NAIMA AH115, the written recommendation of the fibrous duct manufacturer shall be followed.

3.1.17 Acoustical Duct Lining

Lining shall be applied in cut-to-size pieces attached to the interior of the duct with nonflammable, fire-resistant adhesive conforming to ASTM C 916, Type I, NFPA 90A, UL 723, and ASTM E 84. Top and bottom pieces shall lap the side pieces and shall be secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed in accordance with SMACNA TAB HVAC Sys. Welded pins, cup-head pins, or adhered clips shall not distort the duct, burn through, nor mar the finish or the surface of the duct. Pins and washers shall be flush with the surfaces of the duct liner and all breaks and punctures of the duct liner coating shall be sealed with the nonflammable, fire-resistant adhesive. Exposed edges of the liner at the duct ends and at other joints where the lining will be subject to erosion shall be coated with a heavy brush coat of the nonflammable, fire-resistant adhesive to prevent delamination of glass fibers. Duct liner may be applied to flat sheet metal prior to forming duct through the sheet metal brake. Lining at the top and bottom surfaces of the duct shall be additionally secured by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in SMACNA TAB HVAC Sys to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, will be acceptable.

3.1.18 Field Applied Insulation

Field applied insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.19 Factory Applied Insulation

[Refrigerant suction lines between an evaporator and compressors [and any cold gas inlet connections to gas cooled motors]] [Refrigerant pumps and exposed chilled water lines] shall be insulated with not less than 3/4 inch thick unicellular plastic foam.

3.1.20 Framed Instructions

Framed instructions shall be framed under glass or laminated plastic and be posted where directed. Instructions shall include equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The instructions shall be posted before acceptance testing of the system.

3.2 TESTS

Tests shall be conducted in the presence of the Contracting Officer. Utilities for testing shall be provided as specified in the SPECIAL CONTRACT REQUIREMENTS. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. The services of a qualified technician shall be provided as required to perform all tests and procedures indicated herein. Field tests shall be coordinated with Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.2.1 Condenser Water System

After cleaning, water piping shall be hydrostatically tested at a pressure equal to 150 percent of the total system operating pressure for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Leaks shall be repaired and piping retested until test is successful. No loss of pressure shall be allowed. Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before concealing.

3.2.2 Refrigerant System

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NOTE: The following refrigerant system tests are for field fabricated refrigerant piping systems. The tests do not apply to packaged, unitary systems which are charged at the factory.

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After all components of the refrigerant system have been installed and connected, the entire refrigeration system shall be subjected to a pneumatic test as described herein.

3.2.2.1 Preliminary Procedures

Prior to pneumatic testing, equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, shall be isolated from the test pressure or removed from the system. Safety relief valves and rupture discs, where not part of factory sealed systems, shall be removed and openings capped or plugged.

3.2.2.2 Pneumatic Test

Pressure control and excess pressure protection shall be provided at the source of test pressure. Valves shall be wide open, except those leading to the atmosphere. Test gas shall be dry nitrogen, with minus 70 degree F dewpoint and less than 5 ppm oil. Test pressure shall be applied in two stages before any refrigerant pipe is insulated or covered. First stage test shall be at 10 psi with every joint being tested with a thick soap or color indicating solution. Second stage tests shall raise the system to the minimum refrigerant leakage test pressure specified in ASHRAE 15 with a maximum test pressure 25 percent greater. Pressure above 100 psig shall be raised in 10 percent increments with a pressure acclimatizing period between increments. The initial test pressure shall be recorded along with the ambient temperature to which the system is exposed. Final test pressures of the second stage shall be maintained on the system for a minimum of 24 hours. At the end of the 24 hour period, the system pressure will be recorded along with the ambient temperature to which the system is exposed. A correction factor of 0.3 psi will be allowed for each degree F change between test space initial and final ambient temperature, plus for increase and minus for a decrease. If the corrected system pressure is not exactly equal to the initial system test pressure, then the system shall be investigated for leaking joints. To repair leaks, the joint shall be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, remelting, or back-welding/brazing shall not be acceptable. Following repair, the entire system shall be retested using the pneumatic tests described above. The entire system shall be reassembled once the pneumatic tests are satisfactorily completed.

3.2.2.3 Evacuation Test

Following satisfactory completion of the pneumatic tests, the pressure shall be relieved and the entire system shall be evacuated to an absolute pressure of 300 micrometers. During evacuation of the system, the ambient temperature shall be higher than 35 degrees F. No more than one system shall be evacuated at one time by one vacuum pump. Once the desired vacuum has been reached, the vacuum line shall be closed and the system shall stand for 1 hour. If the pressure rises over 500 micrometers after the 1 hour period, then the system shall be evacuated again down to 300 micrometers and let set for another 1 hour period. The system shall not be charged until a vacuum of at least 500 micrometers is maintained for a period of 1 hour without the assistance of a vacuum line. If during the testing the pressure continues to rise, check the system for leaks, repair as required, and repeat the evacuation procedure. During evacuation, pressures shall be recorded by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

3.2.2.4 System Charging and Startup Test

Following satisfactory completion of the evacuation tests, the system shall be charged with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures. Following charging, the system shall operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. The entire system shall be tested for leaks. Fluorocarbon systems shall be tested with halide torch or electronic leak detectors.

3.2.2.5 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

3.2.2.6 Contractor's Responsibility

The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim.

At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.2.3 Ductwork Leak Tests

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NOTE: This paragraph may be omitted where all ductwork is constructed to static pressure Class 125, 250, 500 Pa (1/2, 1 or 2 inch W.G.). Otherwise, leakage rate will be derived for each system to be tested based on procedure outlined in SMACNA Leakage Test Mnl for Seal Class A. If round/oval metal ductwork only is specified C sub L = 3 will be used, otherwise C sub L = 6 may be used. The value of P used will be equal to the highest duct static pressure class; i.e., 750, 1000, 1500, or 2500 Pa (3, 4, 6, or 10), for the ductwork to be tested. Where major components such as fans, coils, filters, etc., will be included in ductwork test, an appropriate allowance will be included in the maximum allowable leakage rate.

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Ductwork leak test shall be performed for the entire air distribution system, including fans, coils, filters, etc., [designated as static pressure Class 3 inch water gauge through Class 10 inch water gauge.] Test procedure, apparatus, and report shall conform to SMACNA Leakage Test Mnl. The maximum allowable leakage rate is [_____] CFM. Ductwork leak test shall be completed with satisfactory results prior to applying insulation to ductwork exterior.

3.2.4 Cooling Tower Tests

After cooling tower have been found acceptable under the visual and dimensional examination, a field performance test shall be performed in accordance with ASME PTC 23 or CTI ATC-105. [The [electromagnetic interference suppression test and the] [salt spray test is not required].] The cooling tower test shall be performed in the presence of a Government representative.

3.2.5 Condenser Water Quality Tests

The condenser water shall be analyzed a minimum of once a month for a period of one year by the water treatment company. The analysis shall include the following information recorded in accordance with ASTM D 596.

Date of Sample	[_____]
Temperature	[_____] degrees F
Silica (SiO2)	[_____] ppm (mg/1)
Insoluble	[_____] ppm (mg/1)
Iron and Aluminum Oxides	[_____] ppm (mg/1)
Calcium (Ca)	[_____] ppm (mg/1)
Magnesium (Mg)	[_____] ppm (mg/1)
Sodium and Potassium (Na and K)	[_____] ppm (mg/1)

Carbonate (HCO_3)	[_____] ppm (mg/1)
Sulfate (SO_4)	[_____] ppm (mg/1)
Chloride (Cl)	[_____] ppm (mg/1)
Nitrate (NO_3)	[_____] ppm (mg/1)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] epm (meq/1)
Non-Carbonate Hardness	[_____] epm (meq/1)
Total Hardness	[_____] epm (meq/1)
Dissolved Solids	[_____] ppm (mg/1)
Fluorine	[_____] ppm (mg/1)
Conductivity	[_____] micrmho/cm

3.2.6 System Performance Tests

After the foregoing tests have been completed and before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment shall be conducted by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Tests shall cover a period of not less than [48] [_____] hours for each system and demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points shall be installed and tightened. Any refrigerant lost during the system startup shall be replaced. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested.

3.3 INSPECTIONS

At the conclusion of the one year period, cooling towers and condensers shall be inspected for problems due to corrosion, scale, and biological growth. If the cooling tower and condenser are found not to conform to the manufacturers recommended conditions, assuming the water treatment company recommendations have been followed; the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

3.4 CLEANING AND ADJUSTING

3.4.1 Piping

Prior to testing, pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from each water system through the use of the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented.

3.4.2 Ductwork

Prior to testing, inside of ducts, plenums, and casing shall be thoroughly cleaned of all debris and blown free of small particles of rubbish and dust and then vacuum cleaned before installing outlet faces. Temporary filters shall be provided for fans that are operated during construction. New filters shall be installed after all construction dirt has been removed from the building and the ducts, plenum, casings, and other items specified have been vacuum cleaned. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.4.3 Equipment

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. System shall be maintained in this clean condition until final acceptance. Bearings shall be lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed.

3.4.4 Testing, Adjusting, and Balancing

Testing, adjusting, and balancing shall be as specified in Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS.

3.5 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total [_____] hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

-- End of Section --

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U.S. ARMY CORPS OF ENGINEERS | **-------------------------**

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GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 9 (May 1999)
Includes Special Change (Tailoring Options) (June 1998)
Includes Text Adjustment Change (Section Reference) (June 1997)

Latest change indicated by CHG tags

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DIVISION 15 - MECHANICAL

SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

02/94

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DEPARTMENT OF THE ARMY	**CEGS-15895 (February 1994)**
U.S. ARMY CORPS OF ENGINEERS	**--------------------------**
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GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 9 (May 1999)
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Includes Text Adjustment Change (Section Reference) (June 1997)

Latest change indicated by CHG tags

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SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM
02/94

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NOTE: This guide specification covers the requirements for air supply, distribution, ventilation, and exhaust portion of an HVAC system. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for air systems equipment, air handling units, terminal units, and energy recovery devices. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

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NOTE: The use of this specification will be coordinated with other sections as appropriate in order to specify a complete HVAC built-up system.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 350	(1986) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
ARI 410	(1991) Forced-Circulation Air-Cooling and Air-Heating Coils
ARI 430	(1989) Central-Station Air-Handling Units
ARI 440	(1997) Room Fan-Coil and Unit Ventilator
ARI 445	(1987; R 1993) Room Air-Induction Units
ARI 880	(1994) Air Terminals
ARI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

AIR CONDITIONING CONTRACTORS OF AMERICA (ACCA)

ACCA Manual 4	(1990) Installation Techniques for Perimeter Heating & Cooling; 11th Edition

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 210	(1985) Laboratory Methods of Testing Fans for Rating
AMCA Std 300	(1996) Reverberant Room Method for Sound Testing of Fans

AMERICAN BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA Std 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
AFBMA Std 11	

	(1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S12.32	(1990; R 1996) Precision Methods for the Determination of Sound Power Levels of Discrete-Frequency and Narrow-Band Noise Sources in Reverberation Rooms

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990; R 1995) Ferritic Malleable Iron Castings
ASTM A 47M	(1990; R 1996) Ferritic Malleable Iron Castings (Metric)
ASTM A 53	(1997) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 106	(1997a) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 181/A 181M	(1995b) Carbon Steel, Forgings for General-Purpose Piping
ASTM A 183	(1983; R 1998) Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	(1998)(Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 234/A 234M	(1997) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 924/A 924M	(1997a) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1997) Seamless Copper Tube

ASTM B 75M	(1997) Seamless Copper Tube (Metric)
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 88M	(1996) Seamless Copper Water Tube (Metric)
ASTM B 117	(1997) Operating Salt Spray (FOG) Apparatus
ASTM B 650	(1995) Electrodeposited Engineering Chromium Coatings on Ferrous Substrates
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications for Copper and Copper Alloy Tube
ASTM C 916	(1985; R 1996) Adhesives for Duct Thermal Insulation
ASTM C 1071	(1998) Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)
ASTM D 520	(1984; R 1995) Zinc Dust Pigment
ASTM D 1384	(1997a) Corrosion Test for Engine Coolants in Glassware
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 1785	(1996b) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2000	(1998) Rubber Products in Automotive Applications
ASTM D 2466	(1997) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM E 84	(1998el) Surface Burning Characteristics of Building Materials
ASTM E 437	(1992) Industrial Wire Cloth and Screens (Square Opening Series)
ASTM F 872	(1984; R 1990) Filter Units, Air-Conditioning: Viscous-Impingement Type, Cleanable
ASTM F 1199	(1988; R 1993) Cast (All Temperature and

	Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)
ASTM F 1200	(1988; R 1998) Fabricated (Welded) Pipe Line Strainers (Above 150 psig and 150 degrees F)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15	(1994) Safety Code for Mechanical Refrigeration
ASHRAE 52.1	(1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
ASHRAE ANSI/ASHRAE 68	(1986) Laboratory Method of Testing In-Duct Sound Power Measurement Procedures for Fans
ASHRAE 70	(1991) Method of Testing for Rating the Performance of Air Outlets and Inlets
ASHRAE 84	(1991) Method of Testing Air-to-Air Heat Exchangers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995; B16.22a) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(1986; R 1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300

ASME B31.1	(1998) Power Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(1997) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1998) Structural Welding Code - Steel

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1419	(Rev D) Filter Element, Air Conditioning (Viscous-Impingement and Dry Types, Replaceable)

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(1993; Addenda 1995; Errata 1996; 7th Ed. 1998) EJMA Standards

INSTITUTE OF ENVIRONMENTAL SCIENCES (IES)

IES RP-CC-001.3	(1993) HEPA and ULPA Filters

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

MSS SP-110	(1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3; Rev 4) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems
NFPA 96	(1998) Ventilation Control and Fire Protection of Commercial Cooking Equipment

NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION (NAIMA)

NAIMA AH115	(1993) Fibrous Glass Duct Construction Standards

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Industry Practice	(1975) Accepted Industry Practice for Industrial Duct Construction
SMACNA Install Fire Damp HVAC	(1992) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
SMACNA HVAC Duct Const Stds	(1995; Addenda Nov 1997) HVAC Duct Construction Standards - Metal and Flexible
SMACNA Leakage Test Mnl	(1985) HVAC Air Duct Leakage Test Manual

UNDERWRITERS LABORATORIES (UL)

UL 94	(1996; Rev thru Jul 1998) Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 181	(1996; Rev Dec 1998) Factory-Made Air Ducts and Air Connectors
UL 214	(1997) Tests for Flame-Propagation of Fabrics and Films
UL 555	(1995) Fire Dampers
UL 586	(1996) High-Efficiency, Particulate, Air Filter Units
UL 705	(1994; Rev thru Mar 1996) Power Ventilators
UL 723	(1996) Test for Surface Burning Characteristics of Building Materials

UL 900	(1994; Rev thru Apr 1997) Test Performance of Air Filter Units
UL 1995	(1995; Rev thru Jul 1998) Heating and Cooling Equipment
UL Bld Mat Dir	(1998) Building Materials Directory
UL Elec Const Dir	(1998; Supple) Electrical Construction Equipment Directory
UL Fire Resist Dir	(1998) Fire Resistance Directory (2 Vol.)

1.2 COORDINATION OF TRADES

Ductwork, piping offsets, fittings, and accessories shall be furnished as required to provide a complete installation and to eliminate interference with other construction.

1.3 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.4 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

Revise service organization in SD-19 as necessary.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Components and Equipment Data; [_____].

Manufacturer's catalog data shall be included with the detail drawings for the following items. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:

a. Piping Components

b. Ductwork Components

c. Air Systems Equipment

d. Air Handling Units

e. Energy Recovery Devices

f. Terminal Units

SD-04 Drawings

Air Supply, Distribution, Ventilation, and Exhaust Equipment; [_____].

Drawings shall consist of equipment layout including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of all guides and anchors, the load imposed on each support or anchor, and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

SD-06 Instructions

Test Procedures; [_____].

Proposed test procedures for piping hydrostatic test, ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

Welding Procedures; [_____].

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

System Diagrams; GA.

Proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

SD-07 Schedules

Test Schedules; [_____].

Proposed test schedules for hydrostatic test of piping, ductwork leak test, and performance tests, at least 2 weeks prior to the start of related testing.

Field Training Schedule; [_____].

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

SD-08 Statements

Similar Services; [_____].

Statement demonstrating successful completion of similar services on at least 5 projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section.

Welding Qualification; [_____].

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

SD-09 Reports

Test Reports; [_____].

Test reports for the piping hydrostatic test, ductwork leak test, and performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

SD-13 Certificates

Bolts; [_____].

Written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, and the number of each type of bolt to be furnished.

SD-19 Operation and Maintenance Manuals

Air Supply, Distribution, Ventilation, and Exhaust Manuals; [_____].

[Six] [_____] manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing [4] [_____] hour onsite response to a service call on an emergency basis.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Components and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2-year experience shall include applications of components and equipment under similar circumstances and of similar size. The 2 years must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization.

2.2 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.

2.3 NAMEPLATES

Equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.4 EQUIPMENT GUARDS AND ACCESS

****

NOTE: Catwalks, ladders, and guardrails may be required. If so, select the applicable item and indicate on drawings. If not applicable, delete the entire sentence.

****

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified. [Catwalks,] [operating platforms,] [ladders,] [and] [guardrails] shall be provided where shown and shall be constructed according to Section 05500 MISCELLANEOUS METAL.

2.5 PIPING COMPONENTS

2.5.1 Steel Pipe

Steel pipe shall conform to ASTM A 53, Schedule 40, Grade A or B, Type E or S.

2.5.2 Joints and Fittings For Steel Pipe

Joints shall be welded, flanged, threaded, or grooved as indicated. If not otherwise indicated, piping 1 inch and smaller shall be threaded; piping larger than 1 inch and smaller than 3 inches shall be either threaded, grooved, or welded; and piping 3 inches and larger shall be grooved, welded, or flanged. Rigid grooved mechanical joints and fittings may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 230 degrees F. Flexible grooved joints shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein. The manufacturer of each fitting shall be permanently identified on the body of the fitting according to MSS SP-25.

2.5.2.1 Welded Joints and Fittings

Welded fittings shall conform to ASTM A 234/A 234M, and shall be identified with the appropriate grade and marking symbol. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11.

2.5.2.2 Flanged Joints and Fittings

Flanges shall conform to ASTM A 181/A 181M and ASME B16.5, Class 150. Gaskets shall be nonasbestos compressed material according to ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.5. Bolts shall be high or intermediate strength material conforming to ASTM A 193/A 193M.

2.5.2.3 Threaded Joints and Fittings

Threads shall conform to ASME B1.20.1. Unions shall conform to ASME B16.39, Class 150. Nipples shall conform to ASTM A 733. Malleable iron fittings shall conform to ASME B16.3, type as required to match piping.

2.5.2.4 Dielectric Unions and Flanges

Dielectric unions shall have the tensile strength and dimensional requirements specified. Unions shall have metal connections on both ends threaded to match adjacent piping. Metal parts of dielectric unions shall be separated with a nylon insulator to prevent current flow between dissimilar metals. Unions shall be suitable for the required operating pressures and temperatures. Dielectric flanges shall provide the same pressure ratings as standard flanges and provide complete electrical isolation.

2.5.2.5 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 125 psig service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47,and ASTM A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming to ASTM A 106, Grade B or ASTM A 53. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 230 degrees F or Grade No. M3BA610A15B44Z for circulating medium up to 200 degrees F. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

2.5.3 Copper Tube

Copper tube shall conform to ASTM B 88, and ASTM B 88M, Type K or L.

2.5.4 Joints and Fittings For Copper Tube

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and . ASTM B 75. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.5.5 Valves

Valves shall be Class 125 and shall be suitable for the intended application. Valves shall meet the material, fabrication and operating requirements of ASME B31.1. Chain operators shall be provided for valves located 10 feet or higher above the floor. Valves in sizes larger than 1 inch and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be provided by the same manufacturer as the grooved pipe joint and fitting system.

2.5.5.1 Gate Valves

Gate valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with rising stem and threaded, solder, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70 and shall be cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.5.5.2 Globe Valves

Globe valves 2-1/2 inches and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Globe valves 3 inches and larger shall conform to MSS SP-85 and shall be cast iron with bronze trim and flanged, or threaded ends.

2.5.5.3 Check Valves

Check valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Check valves 3 inches and larger shall conform to MSS SP-71and shall be cast iron with bronze trim and flanged or threaded ends.

2.5.5.4 Angle Valves

Angle valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Angle valves 3 inches and larger shall conform to MSS SP-85and shall be cast iron with bronze trim and flanged, or threaded ends.

2.5.5.5 Ball Valves

****

NOTE: Ball valves should be used only for drain valves or in makeup waterlines.

****

Ball valves 1/2 inch and larger shall conform to [MSS SP-72] [or] [MSS SP-110], and shall be ductile iron or bronze with threaded, soldered, or flanged ends.

2.5.5.6 Butterfly Valves

Butterfly valves shall be 2 flange or lug wafer type, and shall be bubble-tight at 150 psig. Valve bodies shall be cast iron, malleable iron, or steel. ASTM A 167, Type 404 or Type 316, corrosion resisting steel stems, bronze or corrosion resisting steel discs, and synthetic rubber seats shall be provided. Valves smaller than 8 inches shall have throttling handles with a minimum of seven locking positions. Valves 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

2.5.5.7 Balancing Valves

****

NOTE: Automatic flow control valves may be deleted.

A supplemental flow measuring scheme or device must be used to measure flow with a manual balancing valve. A calibrated balancing valve incorporates a flow measuring element and can be used in place of a manual balancing valve and a flow measuring device. An automatic flow control valve offers complete flow control in many applications; however, the flow control range is dependent on inlet pressure being within a given range, the flow selection is limited, and, in some cases it may require pump power slightly more than alternative balancing means.

In any facility where typical load imbalances cannot be tolerated and there is a need for automatic control insuring constant hydronic flow, the design will incorporate automatic flow-control valves. The location and capacity of the automatic control valves will be shown on the drawings.

****

Balancing valves 2 inches or smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valves 1 inch or larger may be all iron with threaded or flanged ends. The valves shall have a square head or similar device and an indicator arc and shall be designed for 250 degrees F. Iron valves shall be lubricated, nonlubricated, or tetrafluoroethylene resin-coated plug valves. In lieu of plug valves, ball valves may be used. Plug valves and ball valves 8 inches or larger shall be provided with manual gear operators with position indicators. [In lieu of balancing valves specified] [Where indicated], automatic flow control valves may be provided to maintain constant flow, and shall be designed to be sensitive to pressure differential across the valve to provide the required opening. Valves shall be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Valves shall control the flow within 5 percent of the tag rating. Valves shall be suitable for the maximum operating pressure of 125 psig or 150 percent of the system operating pressure, whichever is the greater. Where the available system pressure is not adequate to provide the minimum pressure differential that still allows flow control, the system pump head capability shall be appropriately increased. Where flow readings are provided by remote or portable meters, valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential across the automatic flow control valve. A portable meter furnished with accessory kit as recommended by the automatic valve manufacturer shall be provided. Automatic flow control valve specified may be substituted for venturi tubes or orifice plate flow measuring devices.

2.5.5.8   Air Vents

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NOTE: Air vents will be shown on drawings; distinguish between manual and automatic air vents.

****

Manual air vents shall be brass or bronze valves or cocks suitable for pressure rating of piping system and furnished with threaded plugs or caps. Automatic air vents shall be float type, cast iron, stainless steel, or forged steel construction, suitable for pressure rating of piping system.

2.5.6   Strainers

****

NOTE: Reference ASTM F 1199 when the operating conditions are at 150 psig and (150 degrees F) or less; otherwise reference ASTM F 1200.

****

Strainer shall be in accordance with [ASTM F 1199] [ASTM F 1200], except as modified herein. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. The strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with removable cover and sediment screen. The screen shall be made of minimum 22 gauge [brass sheet,] [monel,] [corrosion-resistant steel,] with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3,300 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.5.7   Chilled Water System Accessories

Chilled water system accessories such as pumps, combination strainer and suction diffusers, and expansion tanks shall be as specified in Section [15650 CENTRAL REFRIGERATED AIR CONDITIONING SYSTEM] [15653AIR-CONDITIONING SYSTEM (UNITARY TYPE)].

2.5.8   Water or Steam Heating System Accessories

Water or steam heating accessories such as expansion tanks and steam traps shall be as specified in Section 15569 WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH.

2.5.9   Glycol

****

NOTE: When glycol is used, equipment capacities should be adjusted for changes in specific heat and viscosity as shown in the ASHRAE Handbook "HVAC Systems and Equipment". Ethylene glycol should be used unless there is a possibility of contamination

of the potable water system, in which case propylene glycol should be used. The concentration required should be based on the anticipated ambient or operating temperature.
****

The glycol shall be tested according to ASTM D 1384 and shall cause less than 0.5 mils penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicon based inhibitors shall not be used. The solution shall be compatible with all wetted items within the system.

2.5.10 Backflow Preventers

Backflow preventers shall be according to Section 15400 PLUMBING, GENERAL PURPOSE.

2.5.11 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 125 psi or 150 psi service as appropriate for the static head plus the system head, and 250 degrees F, 230 degrees F for grooved end flexible connectors. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. The flexible section shall be suitable for intended service with end connections to match adjacent piping. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

2.5.12 Pressure Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 3-1/2 inches in diameter and shall have a range from 0 psig to approximately 1.5 times the maximum system working pressure.

2.5.13 Thermometers

Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 9 inch scale, and shall have rigid stems with straight, angular, or inclined pattern.

2.5.14 Escutcheons

Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or setscrews.

2.5.15 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.5.16 Expansion Joints

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NOTE: Expansion loops, offsets, and bends will be used where possible instead of expansion joints. All expansion provisions, including necessary details, will be shown on the drawings. Expansion joints should be located in serviceable areas.
****

2.5.16.1 Slip Joints

Expansion joints shall provide for either single or double slip of the connected pipes, as required or indicated, and for not less than the traverse indicated. The joints shall be designed for working temperature and pressure suitable for the application, but not less than 150 psig, and shall be according to applicable requirements of EJMA Stds and ASME B31.1. End connections shall be flanged or beveled for welding as indicated. Joint shall be provided with an anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip shall be seamless steel plated with a minimum of 2 mils of hard chrome according to ASTM B 650. All joint components shall be suitable for the intended service. Initial setting shall be made according to the manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer, but in any case shall be not more than 5 feet from expansion joint except that in lines 4 inches or smaller, guides shall be installed not more than 2 feet from the joint. Service outlets shall be provided where indicated.

2.5.16.2 Flexible Ball Joints

****
NOTE: The ball joint only moves in an angular offset or rotation mode. The configuration of the ball joint link will require a 2 or 3 ball joint offset to absorb axial and/or lateral movement.
****

Flexible ball joints shall conform to EJMA Stds and ASME B31.1 and be constructed of alloys as appropriate for the service intended. Where so indicated, the ball joint shall be designed for packing injection under full line pressure to contain leakage. The joint ends shall be threaded to 2 inches only, grooved, flanged, or beveled for welding as indicated or required and shall be capable of absorbing a minimum of 15-degree angular flex and 360 degree rotation. Balls and sockets shall be suitable for the intended service. The exterior spherical surface of carbon steel balls shall be plated with mils of hard chrome according to ASTM B 650. The ball type joints shall be designed and constructed according to EJMA Stds and ASME B31.1 where applicable. Where required, flanges shall conform to ASME B16.5.

2.5.16.3 Bellows Type Joints

Bellows type joints shall be flexible, guided expansion joints. The expansion element shall be stabilized corrosion resistant steel. Bellows type expansion joints shall conform to the applicable requirements of EJMA Stds with internal sleeves. Guiding of piping on both sides of expansion joint shall be according to the published recommendations of the manufacturer of the expansion joint. The joints shall be designed for the working temperature and pressure suitable for the application but not less than 150 psig.

2.5.17 Insulation

Shop and field applied insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.5.18 Condensate Drain Lines

Condensate drainage shall be provided for each item of equipment that generates condensate as specified for drain, waste, and vent piping systems in Section 15400 PLUMBING, GENERAL PURPOSE.

2.6 ELECTRICAL WORK

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NOTE: Electrical characteristics, motor starter type, enclosure type, and maximum rpm should be shown on the drawings in the equipment schedules.

****

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be according to Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 1 hp and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers shall be utilized for motors rated 10 hp or less. Adjustable frequency drives shall be used for larger motors.

2.7 CONTROLS

Controls shall be provided as specified in Section 15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS.

2.8 DUCTWORK COMPONENTS

****

NOTE: The appropriate pressure classification from SMACNA HVAC Duct Const Stds, including points of changes in pressure classification, will be noted on the drawings. Indicate pitch of ductwork, low spots in ductwork, and means of disposing of condensate, where required. Outdoor air intakes should be sized so that rain and snow are not drawn into the ductwork. Watertight intakes shall be sloped to a drain line with provisions made to dispose of the water. The requirement that outdoor air intake

ducts and plenums be fabricated watertight with soldered or brazed joints and seams may be eliminated where it is not anticipated that rain or snow will be drawn into the outdoor air intake.

The use of flexible duct should be limited due to the inordinate pressure drop and corresponding fan energy consumption that it causes. The extent of flexible duct will be shown on the drawings. The designer should also ensure that the restrictions in these standards pertaining to the use of non-metallic materials in air distribution plenums are adhered to.

The flammability and combustibility of non-metallic duct materials is controlled by NFPA 90A, 90B, and 91. The extent of non-metallic duct that can be used should be shown on the drawings when these standards limit its use.
****

2.8.1 Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA HVAC Duct Const Stds unless otherwise specified. Elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure Class 1/2, 1, and 2 inch w.g. ductwork shall meet the requirements of Seal Class C. Class 3 through 10 inch shall meet the requirements of Seal Class A. Sealants shall conform to fire hazard classification specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA HVAC Duct Const Stds. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar will not be acceptable. Outdoor air intake ducts and plenums shall be fabricated with watertight soldered or brazed joints and seams.

2.8.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

2.8.1.2 Metallic Flexible Duct

Metallic type duct shall be single-ply [galvanized steel] [Type 316 stainless steel] [two-ply aluminum] [, self supporting to 8 foot spans]. Duct shall be of corrugated/interlocked, folded and knurled type seam construction, bendable without damage through 180 degrees with a throat radius equal to 1/2 duct diameter. Duct shall conform to UL 181and shall be rated for positive or negative working pressure of 15 inches water gauge at 350 degrees F when duct is aluminum, and 650 degrees F when duct is galvanized steel or stainless steel.

2.8.1.3 Insulated Nonmetallic Flexible Duct Runouts

Flexible duct runouts shall be used only where indicated. Runout length shall be as shown on the drawings, but shall in no case exceed 10 feet. Runouts shall be preinsulated, factory fabricated, and shall comply with NFPA 90A and UL 181. Either field or factory applied vapor barrier shall be provided. Where coil induction or high velocity units are supplied with vertical air inlets, a streamlined and vaned and mitered elbow transition piece shall be provided for connection to the flexible duct or hose. The last elbow to these units, other than the vertical air inlet type, shall be a die-stamped elbow and not a flexible connector. Insulated flexible connectors may be used as runouts. The insulated material and vapor barrier shall conform to the requirements of Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation material surface shall not be exposed to the air stream.

2.8.1.4 General Service Duct Connectors

A flexible duct connector approximately 6 inches in width shall be provided where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL Bld Mat Dir.

2.8.1.5 High Temperature Service Duct Connections

Material shall be approximately 3/32 inch thick, 35 to 40-ounce per square yardweight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 1200 degrees F.

2.8.2 Fibrous Glass Ductwork

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NOTE: Fibrous glass ducts will not be used in air-conditioning systems for medical facilities or in clean rooms with requirements equal to or exceeding Class 100 or in unconditioned spaces in cooling only systems, i.e., cooling only ducts installed in attics.

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Fibrous glass ductwork may be provided in lieu of sheet metal ductwork except that fibrous glass ductwork will not be allowed in fan and equipment rooms, where subject to traffic or weather damage, for outside air intakes, for risers of more than two stories, in kitchen or fume exhaust ducts, to convey solids or corrosive gases, in concrete, for burial below grade, as casings or housings, or in systems used for life support systems. Fibrous glass ductwork, including all components, shall be fabricated according to NAIMA AH115 where the velocity and the static pressure are within its scope. Where the velocity or static pressure exceeds these limits, the ductwork manufacturer shall certify that the ductwork is intended for the velocities and pressures to be encountered, and that the proposed installation meets all performance criteria specified herein for metal ductwork. Fibrous glass ductwork shall have the thermal equivalent of the insulation specified for metal ductwork in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Field or factory fabricated fibrous glass ductwork shall conform to UL 181, Class 1. Duct wall penetrations, transverse joints and longitudinal seams shall be sealed as instructed by the manufacturer by one of the methods prescribed by NAIMA AH115, where applicable, except that pressure sensitive tape shall not be used as a sealant. All items necessary for a complete installation shall be provided as specified for sheet metal duct systems.

2.8.3 Ductwork Accessories

2.8.3.1 Duct Access Doors

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NOTE: Provide duct access doors at regular intervals to facilitate the cleaning of duct systems for applications requiring clean air supplies, such as hospitals, laboratories, electronics servicing and similar activities.

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Access doors shall be provided in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown, shall conform to SMACNA HVAC Duct Const Stds
. Access doors shall be provided upstream and downstream of air flow measuring primaries and heating and cooling coils. Doors shall be minimum 15 x 18 inches, unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Doors 24 x 24 inches or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be the insulated type.

2.8.3.2 Fire Dampers

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NOTE: The designer must indicate on the drawings the location of each fire damper and details of the damper installations. Fire dampers must be provided according to NFPA 90A. Three-hour rated fire dampers must be specifically identified on plans.

****

Fire dampers shall be 1-1/2 hour fire rated unless otherwise indicated. Fire dampers shall conform to the requirements of NFPA 90A and UL 555. The Contractor shall perform the fire damper test as outlined in NFPA 90A. A pressure relief damper shall be provided upstream of the fire damper. If the ductwork connected to the fire damper is to be insulated then this pressure relief damper shall be factory insulated. Fire dampers shall be automatic operating type and shall have a dynamic rating suitable for the maximum air velocity and pressure differential to which it will be subjected. Fire dampers shall be approved for the specific application, and shall be installed according to their listing. Fire dampers shall be equipped with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, will not impair the operation of the damper. Sleeves or frames shall be equipped with perimeter mounting angles attached on both sides of the wall or floor opening. Ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies shall be constructed in conformance with UL Fire Resist Dir. Fire dampers shall be [curtain type with damper blades] [in the air stream] [out of the air stream] [or] [single blade type] [or] [multi-blade type]. Dampers shall not reduce the duct or the air transfer opening cross-sectional area. Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.8.3.3 Splitters and Manual Balancing Dampers

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NOTE: Designer will indicate all volume dampers on the drawings. Diffuser and register volume dampers will not be used for balancing.

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Splitters and manual balancing dampers shall be furnished with accessible operating mechanisms. Where operators occur in finished portions of the building, operators shall be chromium plated with all exposed edges rounded. Splitters shall be operated by quadrant operators or 3/16 inch rod brought through the side of the duct with locking setscrew and bushing. Two rods are required on splitters over 8 inches. Manual volume control dampers shall be operated by locking-type quadrant operators. Dampers and splitters shall be 2 gauges heavier than the duct in which installed. Unless otherwise indicated, multileaf dampers shall be opposed blade type with maximum blade width of 12 inches. Access doors or panels shall be provided for all concealed damper operators and locking setscrews. Unless otherwise indicated, the locking-type quadrant operators for dampers, when installed on ducts to be thermally insulated, shall be provided with stand-off mounting brackets, bases, or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer. Volume dampers shall be provided where indicated.

2.8.3.4 Air Deflectors and Branch Connections

Air deflectors shall be provided at duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections may be used in lieu of deflectors or extractors for branch connections. All air deflectors, except those installed in 90 degree elbows, shall be provided with an approved means of adjustment. Adjustment shall be made from easily accessible means inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, external adjustments shall be provided with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Air deflectors shall be factory-fabricated units consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Air deflectors shall be factory or field assembled. Blade air deflectors, also called blade air extractors, shall be approved factory fabricated units consisting of equalizing grid and adjustable blade and lock. Adjustment shall be easily made from the face of the diffuser or by position adjustment and lock external to the duct. Stand-off brackets shall be provided on insulated ducts and are described herein. Fixed air deflectors, also called turning vanes, shall be provided in 90 degree elbows.

2.8.4 Duct Sleeves, Framed Prepared Openings, Closure Collars

2.8.4.1 Duct Sleeves

Duct sleeves shall be provided for round ducts 15 inches in diameter or less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round ducts larger than 15 inches in diameter and square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 20 gauge galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53, Schedule 20 shall be used. Sleeve shall provide 1 inch clearance between the duct and the sleeve or 1 inch clearance between the insulation and the sleeve for insulated ducts.

2.8.4.2 Framed Prepared Openings

Openings shall have 1 inch clearance between the duct and the opening or 1 inch clearance between the insulation and the opening for insulated ducts.

2.8.4.3 Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 4 inches wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 15 inches in diameter or less shall be fabricated from 20 gauge galvanized steel. Collars for round ducts larger than 15 inches and square, and rectangular ducts shall be fabricated from 18 gaugegalvanized steel. Collars shall be installed with fasteners on maximum 6 inch centers, except that not less than 4 fasteners shall be used.

2.8.5 Plenums and Casings for Field-Fabricated Units

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NOTE: If field-fabricated air handling units are not used, delete this paragraph entirely. Delete inapplicable sentences or items. Delete the

push-button station if not required.
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2.8.5.1 Plenum and Casings

Plenums and casings shall be fabricated and erected as shown in SMACNA HVAC Duct Const Stds, as applicable. Unless otherwise indicated, system casing shall be constructed of not less than 16 gauge galvanized sheet steel. Cooling coil drain pans with 1 inch threaded outlet shall be provided to collect condensation from the cooling coils. Drain pans shall be fabricated of not lighter than 16 gauge steel, galvanized after fabrication or of 18 gauge corrosion-resisting sheet steel conforming to ASTM A 167, Type 304, welded and stiffened. Drain pans exposed to the atmosphere shall be thermally insulated to prevent condensation. Insulation shall be coated with a flame resistant waterproofing material. Separate drain pans shall be provided for each vertical coil section, and a separate drain line shall be provided for each pan. Pans shall be generously sized to ensure capture of entrained moisture on the downstream-air side of the coil. Openings in the casing, such as for piping connections, shall be sealed and covered to prevent air leakage. Water seal for the drain shall provide at least 2 inch water gauge greater than the maximum negative pressure in the coil space.

2.8.5.2 Casing

Casings shall be terminated at the curb line and anchored by the use of galvanized angle iron sealed and bolted to the curb, as indicated in SMACNA HVAC Duct Const Stds.

2.8.5.3 Access Doors

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NOTE: Designer should determine whether an electrical push-button to stop the fan by a person inside the casing is required. If required, the drawings will be checked to ensure that the item is shown, and properly coordinated with electrical drawings.
****

Access doors shall be provided in each section of the casing. Door frames shall be welded in place, and each door shall be neoprene gasketed, hinged with minimum of two brass hinges, and fastened with a minimum of two brass tension fasteners operable from inside and outside of the casing. Where possible, doors shall be 36 x 18 inches located 18 inches above the floor. Where the space available will not accommodate doors of this size, doors as large as the space will accommodate shall be provided. Doors shall swing so that fan suction or pressure holds door in closed position, and shall be airtight. A push-button station to stop the supply fan shall be located inside the casing where indicated.

2.8.5.4 Factory-Fabricated Insulated Sheet Metal Panels

Factory-fabricated components may be used for field-assembled units, provided all requirements specified for field-fabricated plenums and casings are met. Panels shall be of modular design, pretested for structural strength, thermal control, condensation control, and acoustical control. Panel joints shall be sealed and insulated access doors shall be provided and gasketed to prevent air leakage. Panel construction shall be not less than 20 gauge galvanized sheet steel and shall be assembled with fasteners treated against corrosion. Standard length panels shall deflect not more than 1/2 inch under operation. Details of construction, including joint sealing, not specifically covered shall be as indicated in SMACNA HVAC Duct Const Stds. The plenums and casings shall be constructed to withstand the specified internal pressure of the air systems.

2.8.5.5 Duct Liner

Unless otherwise specified, duct liner shall conform to ASTM C 1071, Type I or II.

2.8.6 Sound Attenuation Equipment

****

NOTE: Sound attenuators or acoustical duct liner will be used only where acoustical treatment is required and there are no other suitable alternatives. Acoustical duct liner will not be used in systems where the total pressure is above 1000 Pa (4 inches water gauge) in any portion of the air-conditioning system in medical facilities for Army construction.

Refer to TM 5-805-4, Noise and Vibration Control for Mechanical Equipment, for noise criteria. Sound power levels required should be included in the appropriate schedule on the drawings.

****

a. Systems With Total Pressure Above 4 Inches Water Gauge:

Sound attenuators shall be provided on the discharge duct of each fan operating at a total pressure above 4 inch water gauge, and, when indicated, at the intake of each fan system. Sound attenuators shall be provided elsewhere as indicated. The sound attenuators shall be factory fabricated and shall be tested by an independent laboratory for sound and performance characteristics. Net sound reduction shall be as indicated. Maximum permissible pressure drop shall not exceed 0.63 inch water gauge. Traps shall be constructed to be airtight when operating under an internal static pressure of 10 inch water gauge. Air-side surface shall be capable of withstanding air velocity of 10,000 fpm. The Contractor shall certify that the sound reduction values specified will be obtained after the equipment is installed in the system and coordinated with the sound information of the system fan to be provided. Sound absorbing material shall conform to ASTM C 1071, Type I or II. Sound absorbing material shall meet the fire hazard rating requirements for insulation specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. A duct transition section shall be provided for connection to ductwork. Factory fabricated double-walled internally insulated spiral lock seam and round duct and fittings designed for high pressure air system may be provided in lieu of factory fabricated sound attenuators, and shall comply with requirements specified for factory fabricated sound attenuators. The double-walled duct and fittings shall be constructed of an outer metal pressure shell of zinc-coated steel sheet, 1 inch thick acoustical blanket insulation, and an internal perforated zinc-coated metal liner. Sufficient length of run shall be provided to obtain the noise reduction coefficient specified. The

Contractor shall certify that the sound reduction value specified will be obtained within the length of duct run provided. The outer sheet metal of the double-walled duct shall have welded, or spiral lock, seams to prevent water vapor penetration. The outer sheet of the duct and fittings shall conform to the metal thickness of high pressure spiral and round ducts and fittings shown in SMACNA HVAC Duct Const Stds. The acoustical insulation shall have a thermal conductivity "k" of not more than 0.27 Btu/inch/square foot/hour/degree F at 75 degrees F mean temperature. The internal perforated zinc-coated metal liner shall be not less than 24 gauge with perforations not larger than 1/4 inch in diameter providing a net open area not less than 10 percent of the surface.

a. System With Total Pressure of 4 Inch Water Gauge and Lower:

Sound attenuators shall be provided only where indicated, or in lieu of lined ducts. Factory fabricated sound attenuators shall be constructed of galvanized steel sheets. Outer casing shall be not less than 22 gauge. Acoustical fill shall be fibrous glass. Net sound reduction shall be as indicated. Values shall be obtained on a test unit not less than 24 inches by 24 inches outside dimensions made by a certified nationally recognized independent acoustical laboratory. Air flow capacity shall be as indicated or required. Pressure drop through the attenuator shall not exceed the value indicated, or shall not be in excess of 15 percent of the total external static pressure of the air handling system, whichever is less. Sound attenuators shall be acoustically tested with metal duct inlet and outlet sections while under the rated air flow conditions. Noise reduction data shall include the effects of flanking paths and vibration transmission. Sound attenuators shall be constructed to be airtight when operating at the internal static pressure indicated or specified for the duct system, but in no case less than 2 inch water gauge.

a. Acoustical Duct Liner:

Acoustical duct lining shall be fibrous glass designed exclusively for lining ductwork and shall conform to the requirements of ASTM C 1071, Type I and II. Liner composition may be uniform density, graduated density, or dual density, as standard with the manufacturer. Lining shall be coated, not less than 1 inch thick. Where acoustical duct liner is used, liner or combination of liner and insulation applied to the exterior of the ductwork shall be the thermal equivalent of the insulation specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Duct sizes shown shall be increased to compensate for the thickness of the lining used. In lieu of sheet metal duct with field-applied acoustical lining, acoustically equivalent lengths of fibrous glass duct or factory fabricated double-walled internally insulated duct with perforated liner may be provided. Net insertion loss value, static pressure drop, and air flow velocity capacity data shall be certified by a nationally recognized independent acoustical laboratory.

2.8.7 Diffusers, Registers, and Grilles

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NOTE: Coordinate with paragraph Sound Attenuation Equipment.

If diffusers or registers or grilles are not required, reference to the omitted items will be deleted. Specified performance characteristics peculiar to the omitted items will be deleted. If

any one or two of the three types of units are omitted, the corresponding subparagraph will be deleted.
****

Units shall be factory-fabricated of steel, corrosion-resistant steel, or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified according to ASHRAE 70. Inlets and outlets shall be sound rated and certified according to ASHRAE 70. Sound power level shall be as indicated. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers, except linear slot diffusers. Linear slot diffusers shall be provided with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, they shall be protected by a grille or screen according to NFPA 90A.

2.8.7.1 Diffusers

Diffuser types shall be as indicated. Ceiling mounted units shall be furnished with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Diffusers shall be provided with air deflectors of the type indicated. Air handling troffers or combination light and ceiling diffusers shall conform to the requirements of UL Elec Const Dir for the interchangeable use as cooled or heated air supply diffusers or return air units. Ceiling mounted units shall be installed with rims tight against ceiling. Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller. Return or exhaust units shall be similar to supply diffusers.

2.8.7.2 Registers and Grilles

Units shall be four-way directional-control type, except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 6 inches below the ceiling unless otherwise indicated. Return and exhaust registers shall be located 6 inches above the floor unless otherwise indicated. Four-way directional control may be achieved by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Grilles shall be as specified for registers, without volume control damper.

2.8.8 Louvers

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NOTE: The designer will ensure that louver selection includes consideration of parameters such as pressure drop and water penetration.
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Louvers for installation in exterior walls which are associated with the air supply and distribution system shall be as specified in Section 07600 SHEET METALWORK, GENERAL.

2.8.9 Air Vents, Penthouses, and Goosenecks

Air vents, penthouses, and goosenecks shall be fabricated from galvanized steel [or aluminum] sheets with galvanized [or aluminum] structural shapes. Sheet metal thickness, reinforcement, and fabrication shall conform to SMACNA HVAC Duct Const Stds. Louver blades shall be accurately fitted and secured to frames. Edges of louver blades shall be folded or beaded for rigidity and baffled to exclude driving rain. Air vents, penthouses, and goosenecks shall be provided with bird screen.

2.8.10 Bird Screens and Frames

Bird screens shall conform to ASTM E 437, Type I, Class 1, 2 by 2 mesh, 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire. Frames shall be removable type or stainless steel or extruded aluminum.

2.8.11 Radon Exhaust Ductwork

Radon exhaust ductwork installed in or beneath slabs shall be fabricated from Schedule 40 PVC pipe that conforms to ASTM D 1785. Fittings shall conform to ASTM D 2466. Solvent cement used to make joints shall conform to ASTM D 2564. Otherwise radon exhaust ductwork shall be metal as specified herein.

2.9 AIR SYSTEMS EQUIPMENT

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NOTE: Items in this paragraph may or may not be required depending on whether field-fabricated air handling units apply or whether equipment external to air handling units are used in the distribution system.

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2.9.1 Fans

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NOTE: Coordinate with paragraph Sound Attenuation Equipment.

Refer to TM 5-805-4, Noise and Vibration Control for Mechanical Equipment, for vibration criteria. Vibration isolation required should be shown and included in the appropriate schedule on the drawings.

The designer will indicate the location of each duct smoke detector in the HVAC system and will indicate the detectors on the schematic and associated ladder diagram. Duct smoke detectors will be provided according to NFPA 90A. Duct detectors are intended to shut associated air distribution fans and smoke

dampers, if provided. Duct smoke detectors are not for use inside ducts where ambient temperatures exceed 38 degrees C (100 degrees F).

When the building is equipped with a fire alarm system, the duct smoke detectors will be connected to the fire alarm control panel (FACP) for alarm initiation. The designer will indicate wiring to the FACP. For existing fire alarm systems, the designer will detail the connection to the FACP.
****

Fans shall be tested and rated according to AMCA 210. Fans may be connected to the motors either directly or indirectly with V-belt drive. V-belt drives shall be designed for not less than [150] [140] [120] percent of the connected driving capacity. Motor sheaves shall be variable pitch for 15 hp and below and fixed pitch as defined by ARI Guideline D. Variable pitch sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts. Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings as indicated. Vibration-isolation units shall be standard products with published loading ratings. Each fan shall be selected to produce the capacity required at the fan static pressure indicated. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA Std 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated.

2.9.1.1 Centrifugal Fans

Centrifugal fans shall be fully enclosed, single-width single-inlet, or double-width double-inlet, AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Impeller wheels shall be rigidly constructed, accurately balanced both statically and dynamically. [Fan blades may be forward curved, backward-inclined or airfoil design in wheel sizes up to 30 inches. Fan blades for wheels over 30 inches in diameter shall be backward-inclined or airfoil design]. [Booster fans for exhaust dryer systems shall be the open-wheel radial type. These fans shall be suitable for conveying lint and the temperatures encountered. The fan shaft shall be provided with a heat slinger to dissipate heat buildup along the shaft. An access (service) door to facilitate maintenance shall be supplied with these fans.] Fan wheels over 36 inches in diameter shall have overhung pulleys and a bearing on each side of the wheel. Fan wheels 36 inches or less in diameter may have one or more extra long bearings between the fan wheel and the drive. Bearings shall be sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Fan shafts shall be steel, accurately finished, and shall be provided with key seats and keys for impeller hubs and fan pulleys. Each fan outlet shall be of ample proportions and shall be designed for the attachment of angles and bolts for attaching flexible connections. [[Manually] [Automatically] operated inlet vanes shall be provided on suction inlets. [Manually] [Automatically] operated outlet dampers shall be provided.] Motors, unless otherwise indicated, shall not exceed 1800 rpm and shall have [open] [dripproof] [totally enclosed] [explosion-proof] enclosures. [Motor starters shall be [manual] [magnetic] [across-the-line] [reduced-voltage-start] type with [general-purpose] [weather-resistant] [watertight] enclosure.] [Remote manual switch with pilot indicating light shall be provided where indicated.]

2.9.1.2 In-Line Centrifugal Fans

In-line fans shall have centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Fans shall be mounted in a welded tubular casing. Air shall enter and leave the fan axially. Inlets shall be streamlined with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt and shall be permanently lubricated, and shall be precision self aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. [Motors shall have [open] [dripproof] [totally enclosed] [explosion-proof] enclosure.] [Motor starters shall be [manual] [magnetic] across-the-line with [general-purpose] [weather-resistant] [explosion-proof] enclosures.] [Remote manual switch with pilot indicating light shall be provided where indicated.]

2.9.1.3 Axial Flow Fans

Axial flow fans shall be complete with drive components and belt guard, and shall have a steel housing, cast fan wheel, cast or welded steel diffusers, fan shaft, bearings, and mounting frame as a factory-assembled unit. Fan wheels shall have radially projecting blades of airfoil cross section and shall be dynamically balanced and keyed to the fan shaft. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt, shall be permanently lubricated or with accessible grease fittings, and shall be precision self-aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours of operation as defined by AFBMA Std 9 and AFBMA Std 11. Fan inlets shall be provided with an aerodynamically shaped bell and an inlet cone. Diffuser or straightening vanes shall be provided at the fan discharge to minimize turbulence and provide smooth discharge air flow. Fan unit shall be provided with [inlet and outlet flanges,] [inlet screen,] [duct equalizer section,] and [manual] [automatic] operation adjustable inlet vanes. Unless otherwise indicated, motors shall not exceed 1800 rpm and shall have [open] [dripproof] [totally enclosed] [explosion-proof] enclosure. [Motor starters shall be [manual] [magnetic] across-the-line with [general-purpose] [weather-resistant] [explosion-proof] enclosure.] [Remote manual switch with pilot indicating light shall be provided where indicated.]

2.9.1.4 Panel Type Power Wall Ventilators

Fans shall be propeller type, assembled on a reinforced metal panel with venturi opening spun into panel. Fans with wheels less than 24 inches diameter shall be direct or V-belt driven and fans with wheels 24 inches diameter and larger shall be V-belt drive type. Fans shall be furnished with wall mounting collar. Lubricated bearings shall be provided. Fans shall be fitted with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Motor enclosure shall be [dripproof] [totally enclosed fan cooled] [explosion-proof] type. [Gravity] [Motor operated] backdraft dampers shall be provided where indicated.

2.9.1.5 Centrifugal Type Power Wall Ventilators

Fans shall be [direct] [or] [V-belt] driven centrifugal type with backward inclined, non-overloading wheel. Motor housing shall be removable and weatherproof. Unit housing shall be designed for sealing to building surface and for discharge and condensate drippage away from building surface. Housing shall be constructed of heavy gauge aluminum. Unit shall be fitted with an [aluminum or plated steel wire discharge bird screen,] [[anodized aluminum] [stainless steel] wall grille,] [manufacturer's standard [gravity] [motor-operated] damper,] an airtight and liquid-tight metallic wall sleeve. Motor enclosure shall be [totally enclosed fan cooled] [dripproof] [explosion-proof] type. Lubricated bearings shall be provided.

2.9.1.6 Centrifugal Type Power Roof Ventilators

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NOTE: Delete kitchen exhaust fan when not required.

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Fans shall be [direct] [or] [V-belt] driven with backward inclined, non-overloading wheel. Motor compartment housing shall be hinged or removable and weatherproof, constructed of heavy gauge aluminum. Fans shall be provided with [birdscreen,] [disconnect switch,] [[gravity] [motorized] dampers,] [sound curb,] [roof curb,] and [extended base]. Motors enclosure shall be [dripproof] [explosion-proof] type. Grease-laden kitchen exhaust fans shall be centrifugal type according to UL 705 and fitted with V-belt drive, round hood, and windband upblast discharge configuration, integral residue trough and collection device, motor and power transmission components located in outside positively air ventilated compartment. Lubricated bearings shall be provided.

2.9.1.7 Propeller Type Power Roof Ventilators

Fans shall be [direct] [or] [V-belt] driven. Fan housing shall be hinged or removable weathertight, fitted with framed rectangular base constructed of aluminum or galvanized steel. Motors shall be [totally enclosed fan cooled] [explosion-proof] type. Motors shall be provided with nonfusible, horsepower rated, manual disconnect mount on unit. Fans shall be provided with [gravity] [motor operated] dampers, [birdscreen] [sound curb] [roof curb]. Lubricated bearings shall be provided.

2.9.1.8 Air-Curtain Fans

****

NOTE: Air curtains designed as fly fans will be provided on all exterior entranceways to food preparation areas, except they will not be required if the entranceway is to be used only as an emergency exit. Air curtains for service windows and service entries will be installed whenever

feasible on the exterior of the entranceway. When air curtains are mounted in locations significantly above normal door heights, curtain air velocities and noise levels should be verified by the designer.
****

Air curtains shall be provided with a weatherproof housing constructed of high impact plastic or minimum 18 gauge rigid welded steel. Fan wheels shall be backward curved, non-overloading, centrifugal type and accurately balanced statically and dynamically. Motors shall have totally enclosed fan cooled enclosures. Motor starters shall be remote manual type with weather-resistant enclosure actuated when the doorway served is open. The air curtains shall attain the air velocities specified within 2 seconds following activation. Air intake and discharge openings shall be protected by bird screens. Air curtain unit or a multiple unit installation shall be at least as wide as the opening to be protected. The air discharge openings shall be so designed and equipped as to permit outward adjustment of the discharge air. Adjustment and installation placement shall be according to the manufacturer's written recommendation. Directional controls on air curtains for service windows shall be designed to be easily cleanable or readily removable. Air curtains shall be designed to prevent the adjustment of the air velocities specified. The interior surfaces of the air curtain units shall be accessible for cleaning. Certified test data indicating that the fan will provide the air velocities required when fan is mounted as indicated shall be furnished. Air curtains designed as fly fans shall be provided where indicated. [Air curtains designed for use in service entranceways shall develop an air curtain not less than 3 inches thick at the discharge nozzle. The air velocity shall be not less than 1600 fpm across the entire entryway when measured 3 feet above the floor.] [Air curtains designed for use on customer entranceways shall develop an air curtain not less than 8 inches thick at the discharge opening. The velocity shall be not less than 600 fpm across the entire entryway when measured 3 feet above the floor. Recirculating type air curtains shall be equipped with readily removable filters, or the filters shall be designed for in-position cleaning. The air capture compartment shall be readily accessible and easily cleanable or designed for in-position cleaning.] [Air curtains designed for use on service windows shall develop an air curtain not less than 8 inches thick at the discharge opening. The air velocity shall be not less than 600 fpm across the entire opening of the service window measured 3 feet below the air discharge opening.]

2.9.1.9 Ceiling Exhaust Fans

Suspended cabinet-type ceiling exhaust fans shall be centrifugal type, direct-driven. Fans shall have acoustically insulated housing. Integral backdraft damper shall be chatter-proof. The integral face grille shall be of egg-crate design or louver design. Fan motors shall be mounted on vibration isolators. Unit shall be provided with mounting flange for hanging unit from above. Fans shall be U.L. listed.

2.9.2 Coils

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NOTE: The designer will research local conditions to determine the effect of corrosive atmosphere on dissimilar metals. Where condenser or evaporator coils are to be installed in corrosive atmospheres, the specification for coils and fins will be

rewritten for these specific conditions. Consideration should be given to the following coil and fin combinations based on past experience with the suitability of these materials in dealing with the local conditions.

a. Copper coil and aluminum fins, coated.

b. Copper coil and copper fins, coated.

c. Aluminum coil and aluminum fins, coated.

d. Aluminum coil and aluminum fins, uncoated.

e. Copper coil and copper fins, uncoated.

Coating may be either phenolic or vinyl. For coils with relatively close fin spacing such as those found in most unitary equipment, the phenolic coating is preferred. Phenolic has less tendency to bridge across the fins than vinyl, has better thermal conductivity than vinyl and in many conditions weathers better than vinyl.
****

Coils shall be fin-and-tube type constructed of seamless [copper] [red brass] tubes and [aluminum] [or] [copper] fins mechanically bonded or soldered to the tubes. [Copper tube wall thickness shall be a minimum of [0.016] [0.020] [0.024] inches.] [Red brass tube wall thickness shall be a minimum of [0.035] [0.049] inches.] [Aluminum fins shall be [0.0055] [0.0075] inch minimum thickness.] [Copper fins shall be 0.0045 inch minimum thickness.] Casing and tube support sheets shall be not lighter than 16 gauge galvanized steel, formed to provide structural strength. When required, multiple tube supports shall be provided to prevent tube sag. Each coil shall be tested at the factory under water at not less than 400 psi air pressure and shall be suitable for 200 psi working pressure. Coils shall be mounted for counterflow service. Coils shall be rated and certified according to ARI 410.

2.9.2.1   Direct-Expansion Coils

Direct-expansion coils shall be suitable for the refrigerant involved. Suction headers shall be seamless copper tubing or seamless or resistance welded steel tube with copper connections. Supply headers shall consist of a distributor which shall distribute the refrigerant through seamless copper tubing equally to all circuits in the coil. Tubes shall be circuited to ensure minimum pressure drop and maximum heat transfer. Circuiting shall permit refrigerant flow from inlet to suction outlet without causing oil slugging or restricting refrigerant flow in coil. Each coil to be field installed shall be completely dehydrated and sealed at the factory upon completion of pressure tests.

2.9.2.2   Water Coils

Water coils shall be installed with a pitch of not less than 1/8 inch per foot of the tube length toward the drain end. Headers shall be constructed of cast iron, welded steel or copper. Each coil shall be provided with a plugged vent and drain connection extending through the unit casing.

2.9.2.3   Steam Heating Coils

Steam coils shall be constructed of cast semisteel, welded steel or copper headers, and [red brass] [copper] tubes. Headers shall be constructed of cast iron, welded steel or copper. Fin tube and header section shall float within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Each coil shall be provided with a field or factory installed vacuum breaker. Coils shall be single-tube type with tubes not less than 1/2 inch outside diameter, except for steam preheat coils. Supply headers shall distribute steam evenly to all tubes at the indicated steam pressure. Coils shall be factory tested to ensure that, when supplied with a uniform face velocity, temperature across the leaving side will be uniform with a maximum variation of no more than 5 percent.

2.9.2.4   Steam Preheat (Nonfreeze) Coils

Steam (nonfreeze) coils shall be steam-distribution-tube type with condensing tubes not less than 1 inch outside diameter for tube lengths 60 inches and over and 1/2 inch outside diameter for tube lengths under 60 inches. Headers shall be constructed of cast iron, welded steel, or copper. Distribution tubes shall be not less than 5/8 inch outside diameter for tube lengths 60 inches and over and 3/8 inch outside diameter for tube lengths under 60 incheswith orifices to discharge steam to condensing tubes. Distribution tubes shall be installed concentric inside of condensing tubes and shall be held securely in alignment. Maximum length of a single coil shall be limited to 144 inches. Coils shall be factory tested to ensure that, when supplied with a uniform face velocity, temperature across the leaving side will be uniform with a maximum variation of no more than 5 percent.

2.9.3   Air Filters

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NOTE: Filters should be selected based on the functional needs of the area served, including indoor air quality. The combination of the extended surface pleated panel filters and the extended surface nonsupported pocket filters are intended to fulfill the filtration requirements in TM 5-810-1, Heating, Ventilating, and Air-Conditioning for areas where indoor air quality is of primary concern.

In the event the retention of efficiency values in the specification becomes cumbersome, the requirements may be revised by referring to the efficiencies indicated on the drawings, to show for each air handling unit or system the efficiency of the air filters required, and the maximum initial resistance.

****

Air filters shall be listed according to requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method shall be as listed under the Label Service and shall meet the requirements of UL 586.

2.9.3.1   Extended Surface Pleated Panel Filters

Filters shall be 2 inch depth, sectional, disposable type of the size indicated and shall have an average efficiency of 25 to 30 percent when tested according to ASHRAE 52.1. Initial resistance at 500 feet per minute shall not exceed 0.36 inches water gauge. Filters shall be UL Class 2. Media shall be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. All four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

2.9.3.2   Extended Surface Nonsupported Pocket Filters

Filters shall be [30] [_____] inch depth, sectional, replaceable dry media type of the size indicated and shall have an average efficiency of 80 to 85 percent when tested according to ASHRAE 52.1. Initial resistance at [500] [_____] feet per minute shall not exceed [0.45] [_____] inches water gauge. Filters shall be UL Class 1. Media shall be fibrous glass, supported in the air stream by a wire or non-woven synthetic backing and secured to a galvanized steel metal header. Pockets shall not sag or flap at anticipated air flows. Each filter shall be installed [with an extended surface pleated panel filter as a prefilter] in a factory preassembled, side access housing or a factory-made sectional frame bank, as indicated.

2.9.3.3   Sectional Cleanable Filters

****

NOTE: Delete washing and charging racks when not required.

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Cleanable filters shall conform to ASTM F 872, and shall be [1] [2] inches thick. Viscous adhesive shall be provided in 5 gallon containers in sufficient quantity for 12 cleaning operations and not less than one quart for each filter section. One washing and charging tank shall be provided for every 100 filter sections or fraction thereof. Each washing and charging unit shall consist of a tank and [single] [double] drain rack mounted on legs. Drain rack shall be provided with dividers and partitions to properly support the filters in the draining position. Initial pressure drop for clean filters shall not exceed the applicable values listed in ASTM F 872.

2.9.3.4   Replaceable Media Filters

Replaceable media filters shall be the [dry-media] [viscous adhesive] type, of the size required to suit the application. Filtering media shall be not less than 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Pad shall be enclosed in a holding frame of not less than 16 gauge galvanized steel, and equipped with quick-opening mechanism for changing filter media. The air flow capacity of the filter shall be based on net filter face velocity not exceeding [300] [_____] feet per minute, with initial resistance of [0.13] [_____] inches water gauge. Average efficiency shall be not less than [_____] percent when tested according to ASHRAE 52.1.

2.9.3.5   Automatic Renewable Media Filters

Automatic, renewable media filters shall consist of a horizontal or vertical traveling curtain of adhesive-coated bonded fibrous glass supplied in convenient roll form. Operation and maintenance requirements of the filter shall not require water supply, sewer connections, adhesive reservoir, or sprinkler equipment. Basic frame shall be fabricated of not less than 14 gauge galvanized steel. Filters shall be sectional design with each section of each filter fully factory assembled, requiring no field assembly other than setting in place next to any adjacent sections and the installation of media in roll form. Each filter shall be complete with initial loading of filter media drive motor adequate to handle the number of sections involved, and [painted steel] [stainless steel] control box containing a warning light to indicate media runout, a runout switch, and a Hand-Off-Auto selector switch. Media feed across the filter face shall be in [full-face increments] [increments] automatically controlled as determined by [filter pressure differential] [time interval control] [time interval control with pressure override] [photo electric control] to provide substantially constant operating resistance to airflow and varying not more than plus or minus 10 percent. Media shall be rolled or enclosed in such a way that collected particulates will not re-entrain. Rolls of clean media, no less than 65 feet long, shall be rerolled on disposable spools in the rewind section of the filter after the media has accumulated its design dirt load. Rewind section shall be equipped with a compression panel to tightly rewind used media for ease of handling. Media shall be of continuous, bonded fibrous glass material, shall be UL Class 2, and shall not compress more than 1/4 inch when subjected to air flow at 500 fpm. Media shall be factory charged with an odorless and flame retardant adhesive which shall not flow while in storage nor when subjected to temperatures up to 175 degrees F. Media shall be supported on both the leaving and entering air faces. The initial resistance of the clean media shall not exceed 0.18 inch water gauge at its rated velocity of 500 fpm. Control shall be set so that the resistance to air flow is between 0.40-and 0.50 inch water gauge unless otherwise indicated. Dust holding capacity under these operating conditions, when operating at a steady state with an upper operating resistance of 0.50 inch water gauge, shall be at least 55 grams of ASHRAE Standard Test Dust per square foot of media area, when tested according to the dynamic testing provisions of ASHRAE 52.1. Average arrestance under these conditions shall be 80 percent. When used in conjunction with factory fabricated air handling units, the horizontal type automatic renewable media filters shall be dimensionally compatible with the connecting air handling units. Horizontal type filter housings shall have all exposed surfaces factory insulated internally with 1 inch, 1-1/2 pound density neoprene coated fibrous glass with thermal conductivity not greater than 0.27 Btu/hour/degree F/square foot/inch of thickness. Access doors for horizontal filters shall be of double wall construction as specified for plenums and casings for field-fabricated units in paragraph DUCTWORK COMPONENTS.

2.9.3.6 Electrostatic Filters

Electrostatic filters shall be the combination dry agglomerator/extended surface nonsupported pocket filter or the combination dry agglomerator/automatic renewable media (roll) type, as indicated. except as modified. Each dry agglomerator electrostatic air filter shall be supplied with the correct quantity of fully housed power packs and equipped with silicon rectifiers, manual reset circuit breakers, low voltage safety cutout, relays for field wiring to remote indication of primary and secondary voltages, and lamps mounted in the cover to indicate these functions locally. Power pack enclosure shall be equipped with external mounting brackets, and low and high voltage terminals shall be fully exposed with access cover removed for ease of installation. Interlock safety switches shall be furnished for each access door and access panel which permits access to either side of the filter, so that the filter will be de-energized in the event that a door or panel is opened. Ozone generation within the filter shall not exceed five parts per one hundred million parts of air. High voltage insulators shall be located outside the moving air stream or on the clean air side of the unit and shall be serviceable. Ionizer wire supports shall be fully exposed and ionizer wires shall be furnished precut to size and with formed loops at each end to facilitate ionizer wire replacement. Agglomerator cell plates shall allow proper air stream entrainment of agglomerates and prevent excessive residual dust build-up. Cells shall be open at the top and bottom to prevent accumulation of agglomerates which settle by gravity. Where the dry agglomerator electrostatic filter is indicated to be the automatic renewable media type, the storage section shall utilize a horizontal or vertical travelling curtain of adhesive-coated bonded fibrous glass for dry agglomerator storage section service and supplied in 65 footlengths in convenient roll form. Storage section construction and roll media characteristics shall otherwise be as specified for automatic renewable media filters. Initial air flow resistance of the dry agglomerator/renewable media combination, after installation of clean media, shall not exceed 0.25 inch water gauge at 500 fpm face velocity. Minimum atmospheric air dust spot efficiency of the combination shall be not less than 90 percent when tested according to ASHRAE 52.1 at an average operating resistance of 0.50 inch water gauge. Where the dry agglomerator electrostatic filter is indicated to be of the extended surface nonsupported pocket filter type, the storage section shall be as specified for extended surface non-supported pocket filters, with sectional holding frames or side access housings as indicated. Initial air flow resistance of the dry agglomerator/extended surface nonsupported pocket filter section combination, after installation of clean filters, shall not exceed 0.65 inch water gauge at 500 fpm face velocity. Minimum atmospheric air dust spot efficiency of the combination shall be not less than 95 percent when tested according to ASHRAE 52.1. Front access filters shall be furnished with full height air distribution baffles and upper and lower mounting tracks to permit the baffles to be moved for agglomerator cell inspection and service. When used in conjunction with factory fabricated air handling units, side access housings shall be supplied which have dimensional compatibility.

2.9.3.7 High-Efficiency Particulate Air (HEPA) Filters

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NOTE: High-efficiency particulate air filters will be used in CLEAN ROOMS (White Rooms or Dust Controlled Facilities), clean work stations, and for critical areas of hospitals. The efficiency of the prefilter will be indicated on the drawings to suit the anticipated contamination load and the degree of prefiltration efficiency required. ASME AG-1 may be referenced either all or in part when extreme temperature or humidity requirements exist. Designer should ensure that requirements added to text from ASME AG-1 are essential to customer's needs, as this standard is not intended for routine commercial applications, and may add unnecessary expense to project. When used, ASME AG-1 should be added to paragraph REFERENCES.

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HEPA filters shall meet the requirements of IES RP-CC-001.3 and shall be individually tested and certified to have an efficiency of not less than [95] [99.97]. Initial resistance at [_____] feet per minute shall not exceed [_____] inches water gauge. Filters shall be constructed by pleating a continuous sheet of filter medium into closely spaced pleats separated by corrugated aluminum or mineral-fiber inserts, strips of filter medium, or by honeycomb construction of the pleated filter medium. Interlocking, dovetailed, molded neoprene rubber gaskets of 5-10 durometer shall be cemented to the perimeter of the [upstream] [downstream] face of the filter cell sides. Adhesive sealer shall be of self-extinguishing rubber-base type or other materials conforming to fire hazard classification specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Filter cell sides shall be [3/4 inch thick exterior grade fire-retardant plywood] [cadmium plated steel] [galvanized steel] assembled in a rigid manner. Overall cell side dimensions shall be correct to 1/16 inch, and squareness shall be maintained to within 1/8 inch. Each holding frame shall use spring loaded fasteners or other devices to seal the filter tightly within it and to prevent any bypass leakage around the filter during its installed life. Air capacity and the nominal depth of the filter shall be as indicated. Each filter shall be installed in a factory preassembled side access housing or a factory-made sectional supporting frame as indicated. Prefilters of the type, construction and efficiency indicated, shall be provided.

2.9.3.8 Range and Griddle Hood Service

Filter shall be sectional, permanent, washable, all metallic media type, nominal 50 mm (2 inches) 2 inches thick, with suitable metal frames, designed for extraction of grease from grease-laden air. Clean filter static pressure drop shall not exceed [_____] inch water gauge when handling [_____] cfmair.

2.9.3.9 Holding Frames

Frames shall be fabricated from not lighter than 16 gauge sheet steel with rust-inhibitor coating. Each holding frame shall be equipped with suitable filter holding devices. Holding frame seats shall be gasketed. All joints shall be airtight.

2.9.3.10 Filter Gauges

Filter gauges shall be dial type, diaphragm actuated draft and shall be provided for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Gauges shall be at least 3-7/8 inches in diameter, shall have white dials with black figures, and [graduations] [shall be graduated in 0.01 inch,] and shall have a minimum range of 1 inch beyond the specified final resistance for the filter bank on which each gauge is applied. Each gauge shall incorporate a screw operated zero adjustment and shall be furnished complete with two static pressure tips with integral compression fittings, two molded plastic vent valves, two 5 foot minimum lengths of 1/4 inch diameter [aluminum] [vinyl] tubing, and all hardware and accessories for gauge mounting.

2.10 AIR HANDLING UNITS

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NOTE: To prevent condensate overflow, calculate the size of condensate drain pans for air handling units

where abnormally high latent loads will be encountered such as high humidity locations or units operating with 100 percent outside air. Where the potential exists for a manufacturer's standard condensate pan to be smaller than the size calculated, include the size required in the equipment schedule on the drawings.
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2.10.1 Field-Fabricated Air Handling Units

Built-up units shall be as specified in paragraph DUCTWORK COMPONENTS. Fans, coils spray-coil dehumidifiers, and air filters shall be as specified in paragraph AIR SYSTEMS EQUIPMENT for types indicated.

2.10.2 Factory-Fabricated Air Handling Units

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NOTE: Coordinate with paragraph Fans and paragraph Coils.
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Units shall be [single-zone draw-through type] [or] [single-zone blow-through type] [or] [multizone blow-through type] [blow-through double-deck type] [blow-through triple deck type] as indicated. Units shall include fans, coils, airtight insulated casing, [prefilters,] [secondary filter sections,] [and] [diffuser sections where indicated,] [air blender] adjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated, [mixing box] [combination sectional filter-mixing box,] [[pan] [drysteam] [spray type] humidifier,] vibration-isolators, and appurtenances required for specified operation. Vibration isolators shall be as indicated. Each air handling unit shall have physical dimensions suitable to fit space allotted to the unit and shall have the capacity indicated. Air handling unit shall have published ratings based on tests performed according to ARI 430.

2.10.2.1 Casings

Casing sections shall be [[single] [2 inch double] wall type] [as indicated,] constructed of a minimum 18 gauge galvanized steel, or 18 gauge steel outer casing protected with a corrosion resistant paint finish according to paragraph FACTORY PAINTING. [Inner casing of double-wall units shall be minimum 20 gauge solid galvanized steel.] Casing shall be designed and constructed with an integral structural steel frame such that exterior panels are non-load bearing. Exterior panels shall be individually removable. Removal shall not affect the structural integrity of the unit. Casings shall be provided with inspection doors, access sections, and access doors as indicated. Inspection and access doors shall be insulated, fully gasketed, double-wall type, of a minimum 18 gauge outer and 20 gauge inner panels. Doors shall be rigid and provided with heavy duty hinges and latches. Inspection doors shall be a minimum 12 inches wide by 12 inches high. Access doors shall be minimum 24 inches wide and shall be the full height of the unit casing or a minimum of 6 ft., whichever is less. [A minimum 8 inches by 8 inches sealed glass window suitable for the intended application shall be installed in all access doors.] Access Sections shall be according to paragraph AIR HANDLING UNITS. Drain pan shall be double-bottom type constructed of 16 gauge [galvanized steel] [stainless steel], pitched to the drain connection.

Drain pans shall be constructed water tight, treated to prevent corrosion, and designed for positive condensate drainage. When 2 or more cooling coils are used, with one stacked above the other, condensate from the upper coils shall not flow across the face of lower coils. Intermediate drain pans or condensate collection channels and downspouts shall be provided, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover. Each casing section handling conditioned air shall be insulated with not less than 1 inch thick, 1-1/2 pound density coated fibrous glass material having a thermal conductivity not greater than 0.23 Btu/hr-sf-F. Factory applied fibrous glass insulation shall conform to ASTM C 1071, except that the minimum thickness and density requirements do not apply, and shall meet the requirements of NFPA 90A. Foam-type insulation is not acceptable. Foil-faced insulation shall not be an acceptable substitute for use on double-wall access doors and inspections doors [and casing sections]. Duct liner material, coating, and adhesive shall conform to fire-hazard requirements specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Exposed insulation edges and joints where insulation panels are butted together shall be protected with a metal nosing strip or shall be coated to conform to meet erosion resistance requirements of ASTM C 1071. A latched and hinged inspection door, shall be provided in the fan and coil sections. Additional inspection doors, access doors and access sections shall be provided [_____] [where indicated].

2.10.2.2 Heating and Cooling Coils

Coils shall be provided as specified in paragraph AIR SYSTEMS EQUIPMENT, for types indicated.

2.10.2.3 Cooling Coils, Spray Type

Cooling coils shall be of the copper finned [direct expansion] [water] type as specified in paragraph AIR SYSTEMS EQUIPMENT furnished complete with water sprays. All horizontal units and vertical units with coil face velocities of 550 fpm or above, shall be provided with moisture eliminators. Sprays shall have all bronze, brass, or stainless steel centrifugal type nozzles, with removable caps designed and arranged for uniform wetting of the entire coil face area. Nozzles shall be supplied by standard weight galvanized steel piping and a centrifugal type circulating pump furnished as an integral part of the unit. Eliminators shall be not lighter than 24 gauge corrosion-resistant steel, removable for maintenance and coil inspection. No water shall carry over into the fan section or supply ducts from the air handling unit provided with or without eliminators.

2.10.2.4 Air Filters

Air filters shall be as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

2.10.2.5 Fans

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NOTE: Coordinate with paragraph Sound Attenuation Equipment.

Refer to TM 5-805-4, Noise and Vibration Control for Mechanical Equipment, for vibration criteria. Vibration isolation required should be shown and

included in the appropriate schedule on the drawings.
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Fans shall be double-inlet, centrifugal type with each fan in a separate scroll. Fans and shafts shall be dynamically balanced prior to installation into air handling unit, then the entire fan assembly shall be statically and dynamically balanced at the factory after it has been installed in the air handling unit. Fans shall be mounted on steel shafts accurately ground and finished. Fan bearings shall be sealed against dust and dirt and shall be precision self-aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Bearings shall be permanently lubricated or lubricated type with lubrication fittings readily accessible at the drive side of the unit. Bearings shall be supported by structural shapes, or die formed sheet structural members, or support plates securely attached to the unit casing. Bearings may not be fastened directly to the unit sheet metal casing. Fans and scrolls shall be furnished with coating indicated. Fans shall be driven by a unit-mounted or a floor-mounted motor connected to fans by V-belt drive complete with belt guard for externally mounted motors. Belt guards shall be the three sided enclosed type with solid or expanded metal face. Belt drives shall be designed for not less than a 1.3 service factor based on motor nameplate rating. Motor sheaves shall be variable pitch for 25 hp and below and fixed pitch above 25 hp as defined by ARI Guideline D. Where fixed sheaves are required, variable pitch sheaves may be used during air balance, but shall be replaced with an appropriate fixed sheave after air balance is completed. Variable pitch sheaves shall be selected to drive the fan at a speed that will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. Motors for V-belt drives shall be provided with adjustable bases. Fan motors shall have [open] [splashproof] [totally enclosed] enclosures. Motor starters shall be [manual] [magnetic] [across-the-line] [reduced-voltage-start] type with [general-purpose] [weather-resistant] [watertight] enclosure. Unit fan or fans shall be selected to produce the required capacity at the fan static pressure. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA Std 300 or ASHRAE ANSI/ASHRAE 68.

2.10.2.6 Access Sections and Filter/Mixing Boxes

Access sections shall be provided where indicated and shall be furnished with access doors as shown. Access sections and filter/mixing boxes shall be constructed in a manner identical to the remainder of the unit casing and shall be equipped with access doors. Mixing boxes shall be designed to minimize air stratification and to promote thorough mixing of the air streams.

2.10.2.7 Diffuser Sections

Diffuser sections shall be furnished between the discharge of all supply fans [and cooling coils of blow-through single zone units] [and] [filter sections of those units with high efficiency filters located immediately downstream of the air handling unit fan section]. Diffuser sections shall be fabricated by the unit manufacturer in a manner identical to the remainder of the unit casing, shall be designed to be airtight under positive static pressures up to [8] [_____] inches water gauge, and shall have an access door on each side for inspection purposes. Diffuser section shall contain a perforated diffusion plate, fabricated of galvanized steel, Type 316 stainless steel, aluminum, or steel treated for corrosion with manufacturer's standard corrosion-resisting finish. The diffusion plate shall be designed to accomplish uniform air flow across the down-stream [coil] [filters] while reducing the higher fan outlet velocity to within plus or minus 5 percent of the required face velocity of the downstream component.

2.10.2.8 Dampers

Dampers shall be as specified in paragraph CONTROLS.

2.11 TERMINAL UNITS

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NOTE: Coordinate with paragraph Sound Attenuation Equipment.
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2.11.1 Room Fan-Coil Units

Base units shall include galvanized coil casing, coil assembly drain pan [valve and piping package,] [outside air damper,] [wall intake box,] air filter, fans, motor, fan drive, and motor switch, plus an enclosure for cabinet models and casing for concealed models. Leveling devices integral with the unit shall be provided for vertical type units. Sound power levels shall be as indicated. Sound power level data or values for these units shall be obtained according to test procedures based on ARI 350. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles. Values obtained for the standard cabinet models will be acceptable for concealed models without separate test provided there is no variation between models as to the coil configuration, blowers, motor speeds, or relative arrangement of parts. Automatic valves and controls shall be provided as specified in paragraph CONTROLS. Each unit shall be fastened securely to the building structure. Capacity of the units shall be as indicated. Room fan-coil units shall be certified as complying with ARI 440, and shall meet the requirements of UL 1995.

2.11.1.1 Enclosures

Enclosures shall be fabricated of not lighter than 18 gaugesteel, reinforced and braced. Front panels of enclosures shall be removable and provided with 1/2 inch thick dual density fibrous glass insulation. The exposed side shall be high density, erosion-proof material suitable for use in air streams with velocities up to 4,500 fpm. Discharge grille shall be [adjustable] [integrally stamped] and shall be of such design as to properly distribute air throughout the conditioned space. Plastic discharge and return grilles are acceptable provided the plastic material is certified by the manufacturer to be classified as flame resistant according to UL 94 and the material shall comply with the heat deflection criteria specified in UL 1995. Ferrous metal surfaces shall be galvanized or factory finished with corrosion resistant enamel. Access doors or removable panels shall be provided for piping and control compartments. Duct discharge collar shall be provided for concealed models. Enclosures shall have easy access for filter replacement.

2.11.1.2 Fans

Fans shall be galvanized steel or aluminum, multiblade, centrifugal type. In lieu of metal, fans and scrolls may be non-metallic materials of suitably reinforced compounds. Fans shall be dynamically and statically balanced. Surfaces shall be smooth. Assemblies shall be accessible for maintenance. Disassembly and re-assembly shall be by means of mechanical fastening devices and not by epoxies or cements.

2.11.1.3 Coils

Coils shall be constructed of not less than 3/8 inch outside diameter seamless copper tubing, with copper or aluminum fins mechanically bonded or soldered to the tubes. Coils shall be provided with not less than 1/2 inch outside diameter flare or sweat connectors, accessory piping package with thermal connections suitable for connection to the type of control valve supplied, and manual air vent. Coils shall be tested hydrostatically at 300 psi or under water at 250 psi air pressure and suitable for 200 psi working pressure. Provisions shall be made for coil removal.

2.11.1.4 Drain Pans

Drain and drip pans shall be sized and located to collect all water condensed on and dripping from any item within the unit enclosure or casing. Drain pans shall be constructed of not lighter than 21 gauge steel, galvanized after fabrication, thermally insulated to prevent condensation. Insulation shall have a flame spread rating not over 25 without evidence of continued progressive combustion, a smoke developed rating no higher than 50, and shall be of a waterproof type or coated with a waterproofing material. In lieu of the above, drain pans may be constructed of die-formed 22 gauge steel, formed from a single sheet, galvanized after fabrication, insulated and coated as specified for the 21 gauge material or of die-formed 21 gauge type 304 stainless steel, insulated as specified above. Drain pans shall be pitched to drain. Minimum 3/4 inch NPT or 5/8 inch OD drain connection shall be provided in drain pan. Auxiliary drain pans to catch drips from control and piping packages, eliminating insulation of the packages, may be plastic; if metal, the auxiliary pans shall comply with the requirements specified above. Insulation at control and piping connections thereto shall extend 1 inch minimum over the auxiliary drain pan.

2.11.1.5 Manually Operated Outside Air Dampers

Manually operated outside air dampers shall be provided according to the arrangement indicated. Dampers shall be parallel airfoil type and of galvanized construction. Blades shall rotate on stainless steel or nylon sleeve bearings.

2.11.1.6 Filters

Filters shall be of the fiberglass disposable type, 1 inch thick, conforming to CID A-A-1419. Filters in each unit shall be removable without the use of tools.

2.11.1.7 Motors

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NOTE: Statements should be deleted depending on whether the units are freestanding, built-in or both Values for high static motors cover 115V, 230V, and 277V..

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Motors shall be of the permanent split-capacitor type with built-in thermal overload protection, directly connected to unit fans. Motor switch shall be two or three speeds and off, manually operated, and shall be mounted on an identified plate [inside the unit below or behind an access door] [or] [adjacent to the room thermostat] [as indicated]. In lieu of the above fan speed control, a solid-state variable-speed controller having a minimum speed reduction of 50 percent may be provided. Motors shall have permanently-lubricated or oilable sleeve-type or combination ball and sleeve-type bearings with vibration isolating mountings suitable for continuous duty. Motor power consumption, shown in watts, at the fan operating speed selected to meet the specified capacity shall not exceed the following values:

Free Discharge Motors

Unit Capacity (cfm)	Maximum Power Consumption (Watts)		
	115V	230V	277V
200	70	110	90
300	100	110	110
400	170	150	150
600	180	210	220
800	240	240	230
1000	310	250	270
1200	440	400	440

High Static Motors

Unit Capacity (cfm)	Maximum Power Consumption (Watts)
200	145
300	145
400	210
600	320
800	320
1000	530
1200	530

2.11.2 Coil Induction Units

Base unit shall include air plenums, air-discharge nozzles, air discharge grilles, recirculation grilles, water coil assembly, valve and piping package, condensate drain pan, and adjustable air-balancing dampers, plus an enclosure for cabinet models and casing for concealed models. Each unit shall be selected to produce not less than the capacity indicated without exceeding the indicated static pressure. The sound power level shall be as indicated. Sound power level data or values for these units shall be based on tests conducted according to ANSI S12.32. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles. The values obtained for the standard cabinet models will be acceptable for concealed models without separate tests, provided there is no variation between models as to coil configuration, air discharge nozzles, air balancing dampers, or relative arrangement of parts. Automatic valves and controls shall be provided as specified in paragraph CONTROLS. Each unit shall be secured to the building structure. Capacity of the units shall be as indicated. The induction units shall conform to the provisions of ARI 445.

2.11.2.1   Enclosures

Enclosures shall be fabricated of not lighter than 18 gaugesteel, reinforced and braced. Front panel of enclosure shall be removable and insulated when required acoustically and to prevent condensation. Discharge grilles shall be [adjustable] [integrally stamped] and shall properly distribute air throughout the conditioned space. Plastic discharge and return grilles are not acceptable. Access doors shall be provided for all piping and control compartments.

2.11.2.2   Air Plenums

Plenums shall be fabricated of galvanized steel with interior acoustically baffled and lined with sound absorbing material that will attenuate the sound power from the primary air supply to the room. Heat-resistant nozzles shall be integral with or attached airtight to the plenum. Where coil induction units are supplied with vertical runouts, a streamlined, vaned, mitered elbow transition piece shall be provided for connection between the unit and ductwork. An adjustable air-balancing damper shall be provided in each unit.

2.11.2.3   Coils

Coils shall be constructed of not less than 3/8 inch outside diameter seamless copper tubing, with copper or aluminum fins, mechanically bonded or soldered to the tubes. Coil connections shall be provided with not less than 1/2 inch outside diameter flare or sweat connectors, accessory piping package with terminal connections suitable for connection to the type of control valve supplied, and manual air vent. Coils shall be tested hydrostatically at 300 psi or under water at 250 psi air pressure and shall be suitable for 200 psi working pressure.

2.11.2.4   Screens

Lint screens or throwaway filters shall be provided for each unit and shall be easily accessible.

2.11.2.5   Drain Pan

Drain and drip pans shall be sized and located to collect condensed water dripping from any item within the unit enclosure. Drain pans shall be constructed of not lighter than 21 gauge steel, galvanized after fabrication, and thermally insulated to prevent condensation. Insulation shall have a flame spread rating not over 25 without evidence of continued progressive combustion, a smoke developed rating no higher than 50, and be of a waterproof type or coated with a waterproofing material. In lieu of the above, drain pans may be constructed of die-formed 22 gauge steel, formed from a single sheet and galvanized after fabrication and insulated and coated as for the 21 gauge steel material or of die-formed 21 gauge type 304 stainless steel insulated as specified above. Drain pans shall be pitched to drain. Drain connection shall be provided when a condensate drain system is indicated. Connection shall be minimum 3/4 inch NPT or 5/8 inch OD.

2.11.3   Variable Air Volume (VAV) and Dual Duct Terminal Units

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NOTE: Delete reheat coils when not required.

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VAV and dual duct terminal units shall be the type, size, and capacity shown and shall be mounted in the ceiling or wall cavity and shall be suitable for single or dual duct system applications. Actuators and controls shall be as specified in paragraph CONTROLS. Unit enclosures shall be constructed of galvanized steel not lighter than 22 gauge or aluminum sheet not lighter than 18 gauge. Single or multiple discharge outlets shall be provided as required. Units with flow limiters are not acceptable. Unit air volume shall be factory preset and readily field adjustable without special tools. Reheat coils shall be provided as indicated. A flow chart shall be attached to each unit. Acoustic performance of the terminal units shall be based upon units tested according to ARI 880. Sound power level shall be as indicated. Discharge sound power shall be shown for minimum and [1-1/2], and [_____] inches water gauge inlet static pressure. Acoustical lining shall be according to NFPA 90A.

2.11.3.1 Constant Volume, Single Duct

Constant volume, single duct, terminal units shall contain within the casing, a mechanical or pneumatic constant volume regulator. Volume regulators shall control air delivery to within plus or minus 5 percent of specified air flow subjected to inlet pressure from 3/4 to 6 inch water gauge.

2.11.3.2 Variable Volume, Single Duct

Variable volume, single duct, terminal units shall be provided with a calibrated air volume sensing device, air valve or damper, actuator, and accessory relays. Units shall control air volume to within plus or minus 5 percent of each air set point volume as determined by the thermostat with variations in inlet pressures from 3/4 to 6 inch water gauge. Internal resistance of units shall not exceed 0.4 inch water gauge at maximum flow range. External differential pressure taps separate from the control pressure taps shall be provided for air flow measurement with a 0 to 1 inch water gauge range. Unit volume controller shall be normally [open] [closed] upon loss of pneumatic pressure.

2.11.3.3 Variable Volume, Single Duct, Fan-Powered

Variable volume, single duct, fan-powered terminal units shall be provided with a calibrated air volume sensing device, air valve or damper, actuator, fan and motor, and accessory relays. Units shall control primary air volume to within plus or minus 5 percent of each air set point as determined by the thermostat with variations in inlet pressure from 3/4 to 6 inch water gauge. Unit fan shall be centrifugal, direct-driven, double-inlet type with forward curved blades. Fan motor shall be either single speed with speed controller or three-speed, permanently lubricated, permanent split-capacitor type. Fan/motor assembly shall be isolated from the casing to minimize vibration transmission. Fan control shall be factory furnished and wired into the unit control system. A factory-mounted pressure switch shall be furnished to operate the unit fan whenever pressure exists at the unit primary air inlet or when the control system fan operates.

2.11.3.4 Dual Duct Terminal Units

Dual duct terminal units shall be provided with hot and cold inlet valve or dampers. Dampers shall be controlled in unison by single or dual actuators. Actuator shall be as specified in paragraph CONTROLS. Unit shall control delivered air volumes within plus or minus 5 percent with inlet air variations from 1 to 8 inch water gauge in either duct. Mixing baffles shall be included with the unit casing. Cabinet and closed duct leakage shall not exceed 2 percent of maximum rated air volume. Internal resistance of units shall not exceed [_____] inch water gauge at maximum flow range.

2.11.3.5 Ceiling Induction Unit

Ceiling induction unit shall be provided with a calibrated primary air volume sensing device, primary air valve, induced air damper, and insulated induction tube. Unit shall be arranged to induce air from the ceiling plenum to maintain a maximum total flow circulated to the conditioned space. Primary air shall be varied upon demand of the room thermostat. Upon a demand for maximum cooling, the unit shall deliver 100 percent primary air and, at minimum cooling, shall deliver [50] [25] percent primary air. Terminal unit shall be capable of closing to full shut off without additional actuators or linkage changes. Terminals shall reset primary air volume within plus or minus 5 percent determined by the thermostat regardless of upstream changes in the static pressure. Minimum inlet static pressure shall not exceed 1 inch water gauge, including a maximum of 0.3 inch water gauge downstream static pressure. External differential pressure taps separate from control pressure taps shall be provided for primary air flow measurement with 0 to 1 inch water gauge range. Each unit shall be normally [open] [closed] upon loss of pneumatic pressure. Actuator and accuracy controls shall be completely factory piped requiring only field installation of 20 psi pneumatic main air and room thermostat.

2.11.3.6 Reheat Units

a. Hot Water Coils: Hot-water coils shall be fin-and-tube type constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to the tubes. Headers shall be constructed of cast iron, welded steel or copper. Casing and tube support sheets shall be 16 gauge, galvanized steel, formed to provide structural strength. Tubes shall be correctly circuited for proper water velocity without excessive pressure drop and they shall be drainable where required or indicated. At the factory, each coil shall be tested at not less than 250 psi air pressure and shall be suitable for 200 psi working pressure. Drainable coils shall be installed in the air handling units with a pitch of not less than 1/8 inch per foot of tube length toward the drain end. Coils shall conform to the provisions of ARI 410.

b. Steam Coils: Steam coils shall be constructed of cast semisteel, welded steel, or copper headers, red-brass or copper tubes, and copper or aluminum fins mechanically bonded or soldered to the tubes. Tubes shall be rolled and bushed, brazed or welded into headers. Coil casings and tube support sheets, with collars of ample width, shall be not lighter than 16 gauge galvanized steel formed to provide structural strength. When required, multiple tube supports shall be provided to prevent tube sag. The fin tube and header section shall float within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Coils shall be factory pressure tested and capable of withstanding 250 psi hydrostatic test pressure or 250 psi air pressure, and shall be for [100] [200] psi steam working pressure. Preheat coils shall be steam-distribution tube type with condensing tubes having not less than 5/8 inch outside diameters. Distribution tubes shall have not less than 3/8 inch outside diameter, with orifices to discharge steam to condensing tubes. Distribution tubes shall be installed concentric inside of condensing tubes and shall be held securely in alignment. The maximum length of a single coil shall be limited to 120 times the diameter of the outside tube. Other heating coils shall be single tube type with not less than 1/2 inchoutside diameter. Supply headers shall distribute steam evenly to all tubes at the indicated steam pressure. Coils shall conform to the provisions of ARI 410.

c. Electric Resistance Heaters: Electric resistance heaters shall be of the duct-mounting type consisting of a nickel-chromium resistor mounted on refractory material and a steel or aluminum frame for attachment to ductwork. Electric duct heater shall meet the requirement of Underwriters Laboratories and NFPA 70 and shall be provided with a built-in or surface-mounted high-limit thermostat. Electric duct heaters shall be interlocked electrically so that heaters cannot be energized unless the fan is running.

2.11.4   Unit Ventilators

Unit ventilators shall include an enclosure, [galvanized casing,] [cold-rolled steel casing with corrosion resistant coating,] coil assembly, [resistance heating coil assembly,] [valve and piping package,] drain pan, air filters, fan assembly, fan drive, motor, motor controller, dampers, and damper operators. Sound power level shall be as indicated. Sound power level data or values for these units shall be obtained according to test procedures based on ARI 350. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles, when handling standard flow for which the unit air capacity is rated. Each unit shall be secured to the building structure. Capacity of the unit ventilators shall be as indicated. Unit ventilators shall be of the year-round classroom type with automatic controls arranged to properly heat, cool, and ventilate the room. Automatic valves and controls shall be provided as specified in paragraph CONTROLS. Sequence of control shall be any one of the standard ANSI cycles specified in paragraph CONTROLS.

2.11.4.1   Enclosures

Enclosures shall be fabricated of not lighter than 16 gaugegalvanized steel, reinforced and braced, or all welded framework with panels to provide equivalent strength. The casing shall be acoustically and thermally insulated internally with not less than 1/2 inch thick dual density fibrous glass insulation. The exposed side shall be high density, erosion-proof material suitable for use in air streams with velocities up to 4,500 fpm. The insulation shall be fastened with waterproof, fire-resistant adhesive. Front panel shall be designed for easy removal by one person. [Discharge grilles shall have adjustable grilles or grilles with adjustable vanes and] [Discharge grilles] shall properly distribute air throughout the conditioned space. Return grilles shall be removable where front panel does not provide access to interior components. Plastic discharge or return grilles are not acceptable. Removable panels or access doors shall be provided for all piping and control compartments. Fan switch shall be key operated or accessible through a locked access panel. Gaskets shall be provided at the back and bottom of the unit for effective air seal, as required.

2.11.4.2   Electric Resistance Heating Elements

Electric resistance heating elements shall be of the sheathed, finned, tubular type, or of the open resistance type designed for direct exposure to the air stream. Heating element electrical characteristics shall be as indicated. Where fan motor or control voltage is lower than required for the electric resistance heating element, a fused factory mounted and wired transformer shall be provided.

2.11.4.3   Fans

Fans shall be of the galvanized steel or aluminum, multiblade, centrifugal type, dynamically and statically balanced. Fan housings shall be provided with resilient mounted, self-aligning permanently lubricated ball bearings, sleeve bearings, or combination ball and sleeve bearings, capable of not less than 2000 hours of operation on one oiling. Fans shall be direct-connected.

2.11.4.4   Coils

Coils shall be circuited for a maximum water velocity of 8 fps without excessive pressure drop and shall otherwise be as specified for hot water coils in paragraph TERMINAL UNITS.

2.11.4.5   Drain Pans

Drain and drip pans shall be sized and located to collect all condensed water dripping from any item within the unit enclosure. Drain pans shall be constructed of not lighter than 18 gauge steel, galvanized after fabrication, and thermally insulated to prevent condensation. Insulation shall be coated with a fire-resistant waterproofing material. In lieu of the above, drain pans may be constructed of die-formed 20 gauge steel, formed from a single sheet and galvanized after fabrication and insulated and coated as for the 18 gauge steel material, or of die-formed 18 gauge type 304 stainless steel insulated as specified above. Drain pans shall be pitched to drain. Drain connection shall be provided when a condensate drain system is indicated. Connection shall be minimum 3/4 inch NDT or 5/8 inch OD.

2.11.4.6   Filters

Fiberglass disposable type, 1 inch thick, conforming to CID A-A-1419, installed upstream of coil.

2.11.4.7   Dampers

An outside air proportioning damper shall be provided on each unit. In addition, a vane shall be provided to prevent excessive outside air from entering unit and to prevent blow-through of outside air through the return air grille under high wind pressures. Where outside air and recirculated air proportioning dampers are provided on the unit, an additional vane will not be required. Face and bypass dampers shall be provided for each unit to ensure constant air volume at all positions of the dampers. Each unit shall be provided with a factory installed control cam assembly, pneumatic motor, or electric motor to operate the face and bypass dampers and outside air damper or outside air and recirculated air dampers in the sequence as specified in paragraph CONTROLS.

2.11.4.8 Motors

****

NOTE: Statements should be deleted depending on whether the units are freestanding, built-in, or both.

****

Motors shall be of the permanent split-capacitor type with built-in thermal overload protection and automatic reset. Motor shall be mounted on a resilient mounting, isolated from the casing and shall be suitable for operation on electric service available. A manually operated motor switch shall provide for 2 or 3 speeds and off and shall be mounted on an identified plate [inside the unit below or behind an access door] [or] [adjacent to the room thermostat] [as indicated]. In lieu of speed control, a solid state variable speed controller having minimum speed reduction of 50 percent may be provided.

2.11.4.9 Outside Air Intakes

Outside air intakes shall be the manufacturer's standard design and provided with 1/2 inch mesh bird screen or louvers on 1/2 inch centers.

2.12 ENERGY RECOVERY DEVICES

2.12.1 Rotary Wheel

****

NOTE: Energy recovery device supply/exhaust filters, preheat coils, backdraft dampers, exhaust dampers, recirculation dampers, face and bypass dampers, drainage provisions, controls and like ancillaries will be shown on the drawings and supplemented by the specifications as necessary. Select minimum acceptable energy transfer effectiveness and maximum acceptable cross-contamination.

Delete moisture resistance and chain drive if not required.

****

Unit shall be a factory fabricated and tested assembly for air-to-air energy recovery by transfer of sensible heat from exhaust air to supply air stream. Device performance shall be according to ASHRAE 84. Device shall deliver an energy transfer effectiveness of not less than [70] [85] [_____] percent with cross-contamination not in excess of [0.1] [1.0] [_____] percent of exhaust airflow rate at system design differential pressure, including purging sector if provided with wheel. Exchange media shall be chemically inert, moisture-resistant, fire-retardant, laminated, nonmetallic material which complies with NFPA 90A. Exhaust and supply streams shall be isolated by seals which are static, field adjustable, and replaceable. Chain drive mechanisms shall be fitted with ratcheting torque limiter or slip-clutch protective device. Enclosure shall be fabricated from galvanized steel and shall include maintenance access provisions. Recovery control and rotation failure provisions shall be as indicated.

2.12.2 Run-Around-Coil

****
NOTE: Delete "factory fabricated and tested" if not required.

Coordinate with paragraph Glycol.
****

Assembly shall be factory fabricated and tested air-to-liquid-to-air energy recovery system for transfer of sensible heat from exhaust air to supply air stream. System shall deliver an energy transfer effectiveness not less than that indicated without cross-contamination with maximum energy recovery at minimum life cycle cost. Components shall be computer optimized for capacity, effectiveness, number of coil fins per inch, number of coil rows, flow rate, heat transfer rate of [_____] percent by volume of [ethylene] [propylene] glycol solution, and frost control. Coils shall conform to paragraph AIR HANDLING UNITS. Related pumps, and piping specialties shall conform to requirements of [Section 15652 COLD STORAGE REFRIGERATION SYSTEM] [Section 15556 FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS] [Section 15653 AIR-CONDITIONING SYSTEM (UNITARY-TYPE)]. System controls shall be as indicated.

2.12.3 Heat Pipe

****
NOTE: Schedule should include face air velocity, static pressure drop, temperature requirements for entering and leaving air or exhaust streams.

Delete flexible connectors if not required.
****

Device shall be a factory fabricated, assembled and tested, counterflow arrangement, air-to-air heat exchanger for transfer of sensible heat between exhaust and supply streams. Device shall deliver an energy transfer effectiveness not less than that indicated without cross-contamination. Heat exchanger tube core shall be [1/2] [5/8] [1] inch nominal diameter, seamless aluminum or copper tube with extended surfaces, utilizing wrought aluminum Alloy 3003 or Alloy 5052, temper to suit. Maximum fins per unit length and number of tube rows shall be as indicated. Tubes shall be fitted with internal capillary wick, filled with an ASHRAE 15, Group 1 refrigerant working fluid, selected for system design temperature range, and hermetically sealed. Heat exchanger frame shall be constructed of not less than 16 gauge galvanized steel and fitted with intermediate tube supports, and flange connections. Tube end-covers and a partition of galvanized steel to separate exhaust and supply air streams without cross-contamination and in required area ratio shall be provided. [A drain pan constructed of welded Type 300 series stainless steel shall be provided.] Heat recovery regulation shall be provided by [system face and bypass dampers and related control system as indicated] [interfacing with manufacturer's standard tilt-control mechanism for summer/winter operation, regulating the supply air temperature and frost prevention on weather face of exhaust side at temperature indicated]. Coil shall be fitted with pleated flexible connectors.

2.13 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123/A 123M or ASTM A 924/A 924M shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphatized and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than 6, average creepage not greater than 1/8 inch. Rating of the inscribed area shall not be less than 10, no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through from the interior shall receive a final shop docket of zinc-rich protective paint according to ASTM D 520 Type I.

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.

3.1.1 Piping

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers. Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Horizontal supply mains shall pitch down in the direction of flow as indicated. The grade shall be not less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the system. Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 2-1/2 inch or less in diameter, and with flanges for pipe 3 inches and larger. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric unions or flanges. All piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded.

3.1.1.1 Joints

a. Threaded Joints: Threaded joints shall be made with tapered threads and made tight with a stiff mixture of graphite and oil or polytetrafluoroethylene tape or equivalent thread joint compound or material, applied to the male threads only.

b. Soldered Joints: Joints in copper tubing shall be cut square with ends reamed, and all filings and dust wiped from interior of pipe.

Joints shall be soldered with 95/5 solder or brazed with silver solder applied and drawn through the full fitting length. Care shall be taken to prevent annealing of tube or fittings when making connections. Joints 2-1/2 inch and larger shall be made with heat uniformly around the entire circumference of the joint with a multi-flame torch. Connections in floor slabs shall be brazed. Excess solder shall be wiped from joint before solder hardens. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B 813.

c. Welded Joints: [Welding shall be according to qualified procedures using qualified welders and welding operators. Procedures and welders shall be qualified according to ASME BPV IX. Welding procedures qualified by others and welders and welding operators qualified by another operator may be permitted by ASME B31.1. Structural members shall be welded according to Section 05055 WELDING, STRUCTURAL. All welds shall be permanently identified by imprinting the welder's or welding operator's assigned symbol adjacent to the weld.] [Welding and nondestructive testing procedures are specified in Section 05093 WELDING PRESSURE PIPING.] Welded joints shall be fusion welded unless otherwise required. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connections may be made with either welding tees or branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. Electrodes shall be stored and dried according to AWS D1.1 or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.1.2 Grooved Mechanical Joints

Grooves shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

3.1.1.3 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

3.1.2 Supports

3.1.2.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load.

Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.2.2 Seismic Requirements (Pipe Supports and Structural Bracing)

****

NOTE: Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not provided. Sections 13080 and 15070, properly edited, must be enclosed in the contract documents.

****

Piping and attached valves shall be supported and braced to resist seismic loads as specified under Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENTand 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT [as shown on the drawings]. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05210 STEEL JOISTS.

3.1.2.3 Pipe Hangers, Inserts and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Types 5, 12, and 26 shall not be used.

a. Hangers: Type 3 shall not be used on insulated piping.

b. Inserts: Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

c. C-Clamps: Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

d. Angle Attachments: Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

e. Hangers: Type 24 may be used only on trapeze hanger systems or on fabricated frames.

f. Type 39 saddles shall be used on all insulated pipe 4 inches and larger when the temperature of the medium is above 60 degrees F. Type 39 saddles shall be welded to the pipe.

g. Type 40 shields shall:

(1) be used on all insulated pipes less than 4 inches.

(2) be used on all insulated pipes 4 inches and larger when the temperature of the medium is 60 degrees or less.

(3) have a high density insert for pipe 2 inches and larger, and for smaller pipe when the insulation shows signs of being visibly compressed, or when the insulation or jacket shows visible signs of distortion at or near the type 40 shield. High density inserts shall have a density of 9 pcf or greater.

h. Horizontal Pipe Supports: Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. [Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.]

i. Vertical Pipe Supports: Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

j. Pipe Guides: Type 35 guides using steel reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

k. Steel Slides: Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger with medium 60 degrees F or greater, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

l. High Temperature Guides with Cradles: Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.

m. Insulated Pipe: Insulation on horizontal pipe shall be continuous through hangers for hot and cold piping. Other requirements on insulated pipe are specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.3 Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

3.1.4 Pipe Sleeves

Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Unless otherwise indicated, sleeves shall provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe or cast iron pipe. Sleeves in non-bearing walls, floors, or ceilings may be steel pipe, cast iron pipe, galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated, or moisture resistant fiber or plastic. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve, in non-fire rated walls, shall be sealed as indicated and specified in Section 07900 JOINT SEALING. Pipes passing through wall waterproofing membrane shall be sleeved as specified above, and a waterproofing clamping flange shall be installed as indicated.

3.1.4.1 Roof and Floor Sleeves

Pipes passing through roof or floor waterproofing membrane shall be installed through a 17-ounce copper sleeve or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a troweled coating of bituminous cement. Unless otherwise shown, the flashing sleeve shall extend up the pipe a minimum of 2 inches above highest floor level or a minimum of 10 inches above the roof. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess. In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

3.1.4.2 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, a fire seal shall be provided as specified in Section 07840 FIRESTOPPING.

3.1.4.3 Escutcheons

Escutcheons shall be provided at finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheons shall be secured to pipe or pipe covering.

3.1.5 Condensate Drain Lines

Water seals shall be provided in the condensate drain from all [units.] [units except room [fan-coil units] [and] [coil-induction units]]. The depth of each seal shall be 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Water seals shall be constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Pipe cap or plug cleanouts shall be provided where indicated. Drains indicated to connect to the sanitary waste system shall be connected by an indirect waste fitting. Air conditioner drain lines shall be insulated as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.6 Pipe-Alignment Guides

Pipe-alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.1.7 Air Vents and Drains

3.1.7.1 Vents

Air vents shall be provided at high points, on water coils, and where indicated to ensure adequate venting of the piping system.

3.1.7.2 Drains

Drains shall be provided at low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.8 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment such as pumps, heaters, heating or cooling coils, and other similar items, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purposes. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

3.1.9 Equipment and Installation

Frames and supports shall be provided for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Air handling units shall be floor mounted or ceiling hung, as indicated. The method of anchoring and fastening shall be as detailed. Floor-mounted equipment, unless otherwise indicated, shall be set on not less than 6 inch concrete pads or curbs doweled in place. Concrete foundations for circulating pumps shall be heavy enough to minimize the intensity of the vibrations transmitted to the piping and the surrounding structure, as recommended in writing by the pump manufacturer. In lieu of a concrete pad foundation, a concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. The concrete foundation or concrete pedestal block shall be of a mass not less than three times the weight of the components to be supported. Lines connected to the pump mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.1.10 Access Panels

Access panels shall be provided for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METALS.

3.1.11 Flexible Connectors

****

NOTE: Flexible connectors will be provided where required to absorb expansion and contraction, isolate vibration, absorb noise, compensate offset motion, absorb continuous flexing, and relieve equipment from piping stresses. Where flexible connectors are needed to correct lateral, parallel, and angular misalignment, their use will be limited to maximum offset as recommended, in writing, by the manufacturer.

****

Pre-insulated flexible connectors and flexible duct shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

3.1.12 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct insulation shall be packed as specified in Section 07840 FIRESTOPPING for fire rated penetrations. For non-fire rated penetrations, the space shall be packed as specified in Section 07900 JOINT SEALING.

3.1.13 Metal Ductwork

Installation shall be according to SMACNA HVAC Duct Const Stds unless otherwise indicated. Duct supports for sheet metal ductwork shall be according to SMACNA HVAC Duct Const Stds, unless otherwise specified. Friction beam clamps indicated in SMACNA HVAC Duct Const Stds shall not be used. Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion. Supports on the risers shall allow free vertical movement of the duct. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

3.1.13.1   Underground Ductwork

****

NOTE: Due to potential contaminants of air-stream, such as pesticides and corrosion, underground ductwork should be used only for exhaust air.

****

Underground ductwork shall be PVC plastisol coated galvanized steel with coating on interior and exterior surfaces and watertight joints. Ductwork shall be installed as indicated, according to ACCA Manual 4 and manufacturer's instructions. Maximum burial depth shall be 6 feet.

3.1.13.2   Radon Exhaust Ductwork

****

NOTE: Subslab ventilation for radon mitigation will be designed as prescribed in TM 5-810-1.

****

Subslab suction piping shall be perforated where indicated. PVC joints shall be installed as specified in ASTM D 2855.

3.1.13.3   Light Duty Corrosive Exhaust Ductwork

Light duty corrosive exhaust ductwork shall be PVC plastisol coated galvanized steel with PVC coating on interior [surfaces.] [and exterior surfaces] [and epoxy wash primer coating on exterior surfaces].

3.1.14   Fibrous Glass Ductwork

Installation shall be according to the manufacturer's written recommendations unless otherwise required in NAIMA AH115. Duct supports for fibrous glass ductwork shall conform to NAIMA AH115. In those cases not covered in NAIMA AH115, the written recommendation of the fibrous duct manufacturer shall be followed.

3.1.15   FRP Ductwork

****

NOTE: Study characteristics of exhaust stream constituents and contaminant materials to determine service life and safety controlling parameters. Consider that constituents concentrate upon evaporation of carrier. Some concentrates detonate upon impact. Design to preclude concentrate high-out water washing may be necessary. Review fire protection provisions, and the need for fire stops. The manufacturer cannot be held responsible for performance of his product, unless the specification delineates product exposure. Modify

or supplement specification criteria as necessary.
****

Fibrous glass reinforced plastic ducting and related structures shall conform to SMACNA Industry Practice. Flanged joints shall be provided where indicated. Crevice-free butt lay-up joints are acceptable where flanged joints are not indicated. When ambient temperatures are lower than 50 degrees F, joints shall be heat cured by exothermic reaction heat packs.

3.1.16 Kitchen Exhaust Ductwork

****
NOTE: The requirements in NFPA 96 pertaining to enclosures around kitchen exhaust ducts shall be shown on the drawings.

The referenced SMACNA HVAC Duct Construction Manual does not cover negative pressures in excess of 3 inches water gauge. If the static pressure within the duct will exceed 3 inches negative, then the spacing and duct thickness must be indicated on the drawings and the paragraph accordingly.
****

3.1.16.1 Ducts Conveying Smoke and Grease Laden Vapors

Ducts conveying smoke and grease laden vapors shall conform to requirements of NFPA 96. Seams, joints, penetrations, and duct-to-hood collar connections shall have a liquid tight continuous external weld. Duct material shall be [minimum 18 gauge, Type 304L or 316L, stainless steel] [minimum 16 gauge carbon steel]. [Duct construction shall include external perimeter angle sized in accordance with SMACNA HVAC Duct Const Stds, except welded joint reinforcement shall be on maximum of 24 inch centers; continuously welded companion angle bolted flanged joints with flexible ceramic cloth gaskets where indicated; pitched to drain at low points; welded pipe coupling-plug drains at low points; welded fire protection and detergent cleaning penetration; steel framed, stud bolted, and flexible ceramic cloth gasketed cleaning access provisions where indicated. Angles, pipe couplings, frames, bolts, etc., shall be same material as that specified for the duct unless indicated otherwise.]

3.1.16.2 Exposed Ductwork

Exposed ductwork shall be fabricated from minimum 18 gauge, Type 304L or 316L, stainless steel with continuously welded joints and seams. Ducts shall be pitched to drain at hoods and low points indicated. Surface finish shall match hoods.

3.1.16.3 Concealed Ducts Conveying Moisture Laden Air

Concealed ducts conveying moisture laden air shall be fabricated from minimum [18 gauge, Type 300 series, stainless steel] [16 gauge, galvanized steel] [16 ounce, tempered copper sheet]. Joints shall be continuously welded, brazed, or soldered to be liquid tight. Duct shall be pitched to drain at points indicated. Transitions to other metals shall be liquid tight, companion angle bolted and gasketed.

3.1.17 Acoustical Duct Lining

Lining shall be applied in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive conforming to ASTM C 916, Type I, NFPA 90A, UL 723, and ASTM E 84. Top and bottom pieces shall lap the side pieces and shall be secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed according to SMACNA HVAC Duct Const Stds. Welded pins, cup-head pins, or adhered clips shall not distort the duct, burn through, nor mar the finish or the surface of the duct. Pins and washers shall be flush with the surfaces of the duct liner and all breaks and punctures of the duct liner coating shall be sealed with the nonflammable, fire resistant adhesive. Exposed edges of the liner at the duct ends and at other joints where the lining will be subject to erosion shall be coated with a heavy brush coat of the nonflammable, fire resistant adhesive, to prevent delamination of glass fibers. Duct liner may be applied to flat sheet metal prior to forming duct through the sheet metal brake. Lining at the top and bottom surfaces of the duct shall be additionally secured by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in SMACNA HVAC Duct Const Stds to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, will be acceptable.

3.1.18 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection shall be provided. The distribution system (supply and return) shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.

3.1.19 Insulation

Thickness and application of insulation materials for ductwork, piping, and equipment shall be according to Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Outdoor air intake ducts and plenums shall be externally insulated [up to the point where the outdoor air reaches the conditioning unit] [or] [up to the point where the outdoor air mixes with the outside air stream].

3.1.20 Duct Test Holes

****

NOTE: The location of duct test holes will be shown on the drawings. Holes should be located so as to implement the requirements of Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

****

Holes with closures or threaded holes with plugs shall be provided in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Extensions, complete with cap or plug, shall be provided where the ducts are insulated.

3.1.21 Power Roof Ventilator Mounting

Foamed 1/2 inch thick, closed-cell, flexible elastomer insulation shall cover width of roof curb mounting flange. Where wood nailers are used, holes shall be pre-drilled for fasteners.

3.1.22 Power Transmission Components Adjustment

V-belts and sheaves shall be tested for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Belts on drive side shall be uniformly loaded, not bouncing. Alignment of direct driven couplings shall be to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.2 FIELD PAINTING AND PIPING IDENTIFICATION

****

NOTE: Color coding for piping identification as required by the using agency will be developed and inserted in the "Color Code Schedule" in Section 09900 PAINTING, GENERAL.

****

Finish painting of items only primed at the factory or surfaces not specifically noted otherwise and identification for piping are specified in Section 09900 PAINTING, GENERAL.

3.3 PIPING HYDROSTATIC TEST

After cleaning, water piping shall be hydrostatically tested at a pressure equal to 150 percent of the total system operating pressure for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Leaks shall be repaired and piping retested until test is successful. No loss of pressure will be allowed. Leaks shall be repaired by re-welding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before covering or concealing.

3.4 DUCTWORK LEAK TEST

****

NOTE: This paragraph may be omitted where all ductwork is constructed to static pressure Class 125, 250, or 500 Pa (1/2, 1, or 2 inch W.G.). Otherwise, leakage rate will be derived for each system to be tested based on procedure outlined in SMACNA Leakage Test Mnl for Seal Class A. If round/oval metal ductwork only is specified C sub L = 3 will be used, otherwise C sub L = 6 may be used. The value of P used will be equal to the highest duct static pressure class; i.e., 3, 4, 6, or 10, for the ductwork to be tested. Where major components such as fans, coils, filters, etc. will be included in ductwork test, an appropriate allowance will be included in the maximum allowable leakage rate.

****

Ductwork leak test shall be performed for the entire air distribution and exhaust system, including fans, coils, [filters, etc.] [filters, etc. designated as static pressure Class 3 inch water gauge through Class 10 inch water gauge.] Test procedure, apparatus, and report shall conform to

SMACNA Leakage Test Mnl. The maximum allowable leakage rate is [_____] cfm. Ductwork leak test shall be completed with satisfactory results prior to applying insulation to ductwork exterior.

3.5 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of foreign matter. A temporary bypass shall be provided for water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Inside of [room fan-coil units] [coil-induction units,] [air terminal units,] [unit ventilators,] ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided prior to startup of all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.6 TESTING, ADJUSTING, AND BALANCING

Testing, adjusting, and balancing shall be as specified in Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS. Testing, adjusting, and balancing shall begin only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.7 PERFORMANCE TESTS

After testing, adjusting, and balancing has been completed as specified, each system shall be tested as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by an experienced engineer. Tests shall cover a period of not less than [_____] days for each system and shall demonstrate that the entire system is functioning according to the specifications. Coincidental chart recordings shall be made at points indicated on the drawings for the duration of the time period and shall record the temperature at space thermostats or space sensors, the humidity at space humidistats or space sensors and the ambient temperature and humidity in a shaded and weather protected area.

3.8 FIELD TRAINING

****

NOTE: The number of hours of instruction should be determined based of the number and complexity of the systems specified.

****

The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of [_____] hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

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SECTION 15950

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SECTION 15950

HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS
08/96

****
NOTE: This guide specification covers the requirements for heating, ventilating and air conditioning control systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: The HVAC Controls System design shall be in accordance with TI 810-11. This specification is based on the use of standard HVAC control systems and the designer shall coordinate the design with this specification. Additionally, the standard drawings, as delineated in TI 810-11, must be utilized in the preparation of the contract drawings and those drawings must be included in the completed design package. Templates for typical contract type drawings, based on the standard drawings in TI

810-11, have been developed and are available in AutoCAD and MicroStation formats from U.S. Army Engineer District, Savannah, ATTN: CESAS-EN-DM, P.O. Box 889, Savannah, GA 31402-0889, telephone 912-652-5386.

Smoke control is not addressed in this guide specification. Smoke-control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 500-D	(1997) Laboratory Meghods of Testing Dampers for Rating

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 269	(1996) Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM D 635	(1997) Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 1693	(1997a) Environmental Stress-Cracking of Ethylene Plastics

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.34	(1997) Valves - Flanged, Threaded, and Welding End

ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 15	Radio Frequency Devices

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

ISA (ISA)

ISA S7.0.01	(1996) Quality Standard for Instrument Air

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 94	(1996; Rev thru Jul 1998) Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 268A	(1998) Smoke Detectors for Duct Application
UL 508	(1993; Rev thru Oct 1997) Industrial Control Equipment
UL 555S	(1999) Safety for Smoke Dampers
UL 916	(1998) Energy Management Equipment

1.2 GENERAL REQUIREMENTS

1.2.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

1.2.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall furnish all work necessary to meet such conditions.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

Under SD-04, HVAC Control System, subparagraph a, repeat sheets four thru nine for each AHU system.

Under SD-08, Training Course Materials, training requirements should be coordinated with the user. Extent of training should be based on the number of systems being installed and the needs of the operation and maintenance staff. If training has been provided through previous projects, the training requirements may be minimal.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment Compliance Booklet; [_____].

An HVAC control system equipment compliance booklet (ECB) in indexed booklet form with numbered tabs separating the information on each device. It shall consist of, but not be limited to, data sheets and catalog cuts which document compliance of all devices and components with the specifications. The ECB shall be indexed in alphabetical order by the unique identifiers. Devices and components which do not have unique identifiers shall follow the devices and components with unique identifiers and shall be indexed in alphabetical order according to their functional name. The ECB shall include a bill of materials for each HVAC control system. The bill of materials shall function as the table of contents for the ECB and shall include the device's unique identifier, device function, manufacturer, model/part/catalog number used for ordering, and tab number where the device information is located in the ECB.

SD-04 Drawings

HVAC Control System; [_____].

Drawings on A1 34 by 22 inch sheets in the form and arrangement shown. The drawings shall use the same abbreviations, symbols, nomenclature and device identifiers shown. Each control-system element on a drawing shall have a unique identifier as shown. All HVAC control system drawings shall be delivered together as a complete submittal. Drawings shall be submitted for each HVAC system.

a. HVAC control system drawings shall include the following:

Sheet One: Drawing index, HVAC control system legend.

Sheet Two: Valve schedule, damper schedule.

Sheet Three: Compressed air station schematic.

Sheet Four: HVAC control system schematic and equipment schedule.

Sheet Five: HVAC control system sequence of operation and ladder diagram.

Sheet Six: HVAC control panel arrangement, control panel cross-section, and control panel inner door layout.

Sheet Seven: HVAC control panel back-panel layout.

Sheet Eight: Control loop wiring diagrams.

Sheet Nine: Motor starter and relay wiring diagram.

Note: Repeat sheets four through nine for each AHU system.

b. An HVAC control system drawing index showing the name and number of the building, military site, State or other similar designation, and Country. The drawing index shall list all HVAC control system drawings, including the drawing number, sheet number, drawing title, and computer filename when used.

c. An HVAC control system legend showing generic symbols and the name of devices shown on the HVAC control system drawings.

d. A valve schedule showing each valve's unique identifier, size, flow coefficient (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure data, dimensions, and access and clearance requirements data.

e. A damper schedule showing each damper and actuator's identifier, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, spring ranges, operation rate, positive positioner ranges, locations of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. The damper schedule shall include the maximum leakage rate at the operating static-pressure differential. The damper schedule shall contain actuator selection data supported by calculations of the torque required to move and seal the dampers, access and clearance requirements.

f. A compressed-air station schematic diagram showing all equipment, including: compressor with motor horsepower and voltage; starter; isolators; manual bypasses; tubing sizes; drain piping and drain traps; reducing valves; dryer; and data on manufacturer's names and model numbers, mounting, access, and clearance requirements. Air compressor and air dryer data shall include calculations of the air consumption of current-to-pneumatic transducers and any other control system devices to be connected to the compressed air station, and the compressed air supply dewpoint temperature at 20 psig.

g. An HVAC control system equipment schedule showing the control loop, device unique identifier, device function, setpoint, input range, and additional important parameters (i.e. output range).

h. An HVAC control system sequence of operation.

I. An HVAC control system ladder diagram showing all relays, contacts, pilot lights, switches, fuses and starters connected to the control system.

j. HVAC control panel arrangement drawings showing both side and front views of the panel. The drawing shall show panel and mounting dimensions.

k. HVAC control panel cross-section drawings showing mounting rails and standoffs for devices.

l. HVAC control panel inner door layout drawings showing both front and rear views of the inner door. The drawings shall show device locations, labels, nameplate legends, and fabrication details.

m. HVAC control panel back-panel layout drawings showing device locations, labels, nameplate legends, terminal block layout, fabrication details, and enclosure operating temperature-rise calculations.

n. HVAC control system wiring diagrams showing functional wiring diagrams of the interconnection of conductors and cables to HVAC control panel terminal blocks and to the identified terminals of devices, starters and package equipment. The wiring diagrams shall show all necessary jumpers and ground connections. The wiring diagrams shall show the labels of all conductors. Sources of power required for HVAC control systems and for packaged-equipment control systems shall be identified back to the panel-board circuit breaker number, HVAC system control panel, magnetic starter, or packaged equipment control circuit. Each power supply and transformer not integral to a controller, starter, or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown.

SD-08 Statements

Commissioning Procedures; [_____] .

a. [Six] [_____] copies of the HVAC control system commissioning procedures, in indexed booklet form, 60 days prior to the scheduled start of commissioning. Commissioning procedures shall be provided for each HVAC control system, and for each type of terminal-unit control system. The commissioning procedures shall reflect the format and language of this specification, and refer to devices by their unique identifiers as shown. The commissioning procedures shall be specific for each HVAC system, and shall give detailed step-by-step procedures for commissioning of the system.

b. Commissioning procedures documenting detailed, product-specific set-up procedures, configuration procedures, adjustment procedures, and calibration procedures for each device. Where the detailed product-specific commissioning procedures are included in manufacturer supplied manuals, reference may be made in the HVAC control system commissioning procedures to the manuals.

c. Commissioning procedures documenting controller configuration checksheets for each controller listing all configuration parameters, dip switch and jumper settings, and initial recommended P, I and D values. The configuration parameters shall be listed in the order in which they appear during the configuration process. Each configuration parameter shall be noted as being: set per specs with no field adjustment required, set per specs but field adjustable, or not applicable.

d. Commissioning procedures showing a time clock configuration checksheet listing all parameters, and switch settings. The parameters shall be listed in the order which they appear during the setup process.

e. An HVAC control system commissioning procedures equipment list that lists the equipment to be used to accomplish commissioning. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

Performance Verification Test Procedures; [_____].

[Six] [_____] copies of the HVAC control system performance verification test procedures, in indexed booklet form, 60 days before the Contractor's scheduled test dates. The performance verification test procedures shall refer to the devices by their unique identifiers as shown, shall explain, step-by-step, the actions and expected results that will demonstrate that the HVAC control system performs in accordance with the sequences of operation. An HVAC control system performance verification test equipment list shall be included that lists the equipment to be used during performance verification testing. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

Training Course Materials; [_____].

[Six] [_____] copies of HVAC control system training course material 30 days prior to the scheduled start of the training course. The training course material shall include the operation manual, maintenance and repair manual, and paper copies of overheads used in the course. An HVAC control system training course, in outline form, with a proposed time schedule. Approval of the planned training schedule shall be obtained from the Government at least [60] [_____] days prior to the start of the training.

SD-09 Reports

Commissioning Report; [_____].

[Six] [_____] copies of the HVAC control system commissioning report, in indexed booklet form, within 30 days after completion of the system commissioning. The commissioning report shall include data collected during the HVAC control system commissioning and shall follow the format of the commissioning procedures. The commissioning report shall include all controller and time clock checksheets with final values listed for all parameters, setpoints, P, I, D setting constants, calibration data for all devices, and results of adjustments.

Performance Verification Test Report; [_____].

[Six] [_____] copies of the HVAC control system performance verification test report, in indexed booklet form, within 30 days after completion of the test. The HVAC control system performance verification test report shall include data collected during the HVAC control system performance verification test. The original copies of data gathered during the performance verification test shall be turned over to the Government after Government approval of the test results.

SD-13 Certificates

ASME Air-Storage Tank Certificate; [_____].

An ASME Air-Storage Tank Certificate for each storage tank.

SD-18 Records

Service Organizations; [_____].

[Six] [_____] copies of a list of service organizations qualified to service the HVAC control system. The list shall include the service organization name, address, technical point of contact and telephone number, and contractual point of contact and telephone number.

SD-19 Operation and Maintenance Manuals

Operation Manual; [_____].

Maintenance and Repair Manual; [_____].

[Six] [_____] copies of the [HVAC control system operation manual] [and] [HVAC control system maintenance and repair manual] for each HVAC control system 30 days before the date scheduled for the training course.

1.4 DELIVERY AND STORAGE

Products shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage-condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

1.5 OPERATION MANUAL

An HVAC control system operation manual for each HVAC control system, in indexed booklet form, shall be provided. The operation manual shall include the HVAC control system sequence of operation, and procedures for the HVAC system start-up, operation and shut-down. The operation manual shall include as-built HVAC control system detail drawings. The operation manual shall include the as-built controller configuration checksheets, the as-built time clock configuration checksheet, the HVAC control system front panel description, the procedures for changing HVAC system controller setpoints, the procedures for gaining manual control of processes, the time clock manufacturer's manual control of processes, the time clock manufacturer's operation manual, and the controller manufacturer's operation manual.

a. The HVAC control system front panel description shall explain the meaning and use of the lights, switches, gauges, and controller displays located in the front panel. Each light, switch, gauge, and display described shall be numbered and referenced to a drawing of the front panel.

b. The procedures for changing HVAC system controller setpoints shall describe the step-by-step procedures required to change: the process variable setpoints of controllers, the alarm setpoints of controllers, the controller bias settings, and controller setpoint reset schedules.

c. The procedures for gaining manual control of processes shall describe step-by-step procedures required to gain manual control of devices and manually adjust their positions.

1.6 MAINTENANCE AND REPAIR MANUAL

An HVAC control system maintenance and repair manual for each HVAC control system, in indexed booklet form in hardback binders, shall be provided. The maintenance and repair manual shall include the routine maintenance checklist, a recommended repair methods list, a list of recommended maintenance and repair tools, the qualified service organization list, the as-built commissioning procedures and report, the as-built performance verification test procedures and report, and the as-built equipment data booklet (EDB).

a. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all devices listed in the equipment compliance booklet (ECB), the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.

b. The recommended repair methods list shall be arranged in a columnar format and shall list all devices in the equipment compliance booklet (ECB) and state the guidance on recommended repair methods, either field repair, factory repair, or whole-item replacement.

c. The as-built equipment data booklet (EDB) shall include the equipment compliance booklet (ECB) and all manufacturer supplied user manuals and information.

d. If the operation manual and the maintenance and repair manual are provided in a common volume, they shall be clearly differentiated and separately indexed.

PART 2 PRODUCTS

2.1 MATERIAL AND EQUIPMENT

Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. The Contractor shall submit a certified list of qualified permanent service organizations and qualifications. These service organizations shall be reasonably convenient to the equipment on a regular and emergency basis during the warranty period.

2.2 GENERAL EQUIPMENT REQUIREMENTS

2.2.1 Electrical and Electronic Devices

****

NOTE: The designer will show the requirement for enclosures other than NEMA Type 1 on the drawings.

****

All electrical, electronic, and electro-pneumatic devices not located within an HVAC control panel shall have a NEMA Type 1 enclosure in accordance with NEMA 250 unless otherwise shown.

2.2.2 Standard Signals

The output of all analog transmitters and the analog input and output of all single-loop controllers and function modules shall be 4-to-20 mAdc signals. The signal shall originate from current-sourcing devices and shall be received by current-sinking devices.

2.2.3 Ambient Temperature Limits

Ambient Temperature Actuators and positive positioners, and transmitters shall operate within temperature limit ratings of 40 to 140 degrees F. All panel-mounted instruments shall operate within limit ratings of 35 to 120 degrees F and 10 percent to 95 percent relative humidity, noncondensing. All devices installed outdoors shall operate within limit ratings of minus 40 to plus 150 degrees F.

2.2.4 Nameplates, Lens Caps, and Tag Nameplates

Nameplates, lens caps, and lens caps bearing legends as shown and tags bearing device-unique identifiers as shown shall have engraved or stamped characters. A plastic or metal tag shall be mechanically attached directly to each device or attached by a metal chain or wire. Each air flow measurement station shall have a tag showing flow rate range for signal output range, duct size, and identifier as shown.

2.2.5 Year 2000 Compliance

All equipment shall be Year 2000 compliant and shall be able to accurately process date/time data (including, but not limited to, calculating, comparing, and sequencing) from, into, and between the twentieth and twenty-first centuries, including leap year calculations, when used in accordance with the product documentation provided by the contractor, provided that all products (e.g. hardware, software, firmware) used in combination with other information technology, shall accurately process date/time data if other information technology properly exchanges date/time data with it.

2.3 MATERIALS

2.3.1 Tubing

2.3.1.1 Copper

Copper tubing shall conform to ASTM B 88 and shall have sweat fittings and valves.

2.3.1.2 Plastic

Plastic tubing shall have barbed fittings and valves. Plastic tubing shall have the burning characteristics of linear low-density polyethylene tubing, shall be self-extinguishing when tested in accordance with ASTM D 635, shall have UL 94 V-2 flammability classification, and shall withstand stress cracking when tested in accordance with ASTM D 1693. Plastic-tubing bundles shall be provided with Mylar barrier and flame-retardant polyethylene jacket.

2.3.1.3 Stainless Steel

Stainless steel tubing shall conform to ASTM A 269, and shall have stainless steel compression fittings.

2.3.2 Wiring

2.3.2.1 Terminal Blocks

Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

2.3.2.2 Control Wiring for 24-Volt Circuits

Control wiring for 24-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 300-volt service.

2.3.2.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 600-volt service.

2.3.2.4 Analog Signal Wiring Circuits

Analog signal wiring circuits within control panels shall not be less than 20 AWG and shall be rated for 300-volt service.

2.3.2.5 Instrumentation Cable

Instrumentation cable shall be 18 AWG, stranded copper, single or multiple-twisted, minimum 2 inch lay of twist, 100 percent shielded pairs, and shall have a 300-volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.3.2.6 Nonconducting Wiring Duct

Nonconducting wiring duct in control panels shall have wiring duct in control panels shall have slotted sides, snap-on duct covers, have slotted sides, snap-on duct covers, fittings for connecting ducts, mounting clips for securing ducts, and wire-retaining clips.

2.3.2.7 Transformers

Step-down transformers shall be utilized where control equipment operates at lower than line circuit voltage. Transformers, other than transformers in bridge circuits, shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage. Transformers shall be sized so that the connected load is 80 percent of the rated capacity or less. Transformers shall conform to UL 508.

2.4 ACTUATORS

****

NOTE: The designer shall show pneumatic or electric actuators on the control-system drawings, and shall choose between electric or electronic and pneumatic actuators based on an estimate of the life cycle cost. If the cost estimate determines that pneumatic actuators are cost-effective and compressed air is not available, the designer will specify a compressed air station and show pneumatic actuators. Positive positioners are not required for electric or electronic actuators. Electric or electronic actuators will be shown for terminal unit control systems.

****

Actuators shall be [pneumatic] [electric or electronic] as shown and shall be provided with mounting and connecting hardware. Electric or electronic actuators shall be used for variable air volume (VAV) air terminal units. Actuators shall fail to their spring-return positions on signal or power failure [,except that VAV terminal unit actuators may be of the floating type]. The actuator stroke shall be limited in the direction of power stroke by an adjustable stop. Actuators shall have a visible position indicator. Actuators shall smoothly open or close the devices to which they are applied and shall have a full stroke response time of 90 seconds or less. Electric actuators shall have an oil-immersed gear train. Electric or electronic actuators operating in series shall have an auxiliary actuator driver. Electric or electronic actuators used in sequencing applications shall have an adjustable operating range and start point. Pneumatic actuators shall be rated for 25 psig operating pressure except for high-pressure cylinder-type actuators.

2.4.1 Valve Actuators

****

NOTE: The designer will calculate the required close-off pressure rating for each valve actuator and show it on the drawings.

****

Valve actuators shall be selected to provide a minimum of 125 percent of the motive power necessary to operate the valve over its full range of operation.

2.4.2 Positive Positioners

Positive positioners are required for pneumatic actuators. Each positive positioner shall be a pneumatic relay with a mechanical feedback mechanism and an adjustable operating range and starting point.

2.5 AUTOMATIC CONTROL VALVES

****

NOTE: The designer will calculate the required Cv for each valve and show it on the drawings.

****

2.5.1 Valve Assembly

Valves shall have stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Unless otherwise stated, valves shall have globe style bodies. Valve bodies shall be designed for not less than 125 psig working pressure or 150 percent of the system operating pressure, whichever is greater. Valve leakage rating shall be 0.01 percent of rated Cv.

2.5.2 Butterfly-Valve Assembly

Butterfly valves shall be threaded lug type suitable for dead-end service, and for modulation to the fully-closed position, with carbon-steel bodies and noncorrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from minus 20 to plus 250 degrees F. Valves shall have a manual means of operation independent of the actuator. The rated Cv for butterfly valves shall be the valve Cv at 70% open (60 degrees open).

2.5.3 Two-Way Valves

Two-way modulating valves shall have equal-percentage characteristics.

2.5.4 Three-Way Valves

Three-way valves shall provide linear flow control with constant total flow throughout full plug travel.

2.5.5 Duct-Coil and Terminal-Unit-Coil Valves

Control valves with either flare-type or solder-type ends shall be provided for duct or terminal-unit coils. Flare nuts shall be furnished for each flare-type end valve.

2.5.6 Valves for Chilled-Water, Condenser-Water, and Glycol Service

Bodies for valves 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 2 to 3 inches inclusive shall be of brass, bronze or iron. Bodies for 2 inch valves shall have threaded ends. Bodies for valves from 2-1/2 to 3 inches shall have flanged-end connections. Valve Cv shall be within 100 percent to 125 percent of the Cv shown. Internal valve trim shall be brass or bronze except that valve stems may be type 316 stainless steel. Valves 4 inches and larger shall be butterfly valves.

2.5.7 Valves for Hot-Water Service

Valves for hot-water service below 250 Degrees F shall be as follows: Bodies for valves 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for 2 inch valves shall have threaded ends. Bodies for valves from 2 to 3 inches inclusive shall be of brass, bronze, or iron. Bodies for valves 4 inches and larger shall be iron. Bodies for valves 2-1/2 inches and larger shall be provided with flanged-end connections. Valve Cv shall be within 100 percent to 125 percent of the Cv shown. Internal trim (including seats, seat rings, modulating plugs, and springs) of valves controlling water hotter than 210 degrees F shall be Type 316 stainless steel. Internal trim for valves controlling water 210 degrees F or less shall be brass or bronze. Nonmetallic parts of hot-water control valves shall be suitable for a minimum continuous operating temperature of 250 degrees F or 50 degrees F above the system design temperature, whichever is higher. Valves 4 inches is higher. Valves 4 inches and larger shall be butterfly valves.

2.5.8 Valves for Steam Service

Bodies for valves 1-1/2 inches and smaller shall be all brass or bronze, with threaded or union ends. Bodies for valves from 2 to 3 inches inclusive shall be of brass, bronze, or iron. Bodies for valves 4 inches and larger shall be iron. Bodies for 2 inches valves shall have threaded ends. Bodies for valves 2-1/2 inches and larger shall be provided with flanged-end connections. Valve Cv shall be not less than shown nor greater than the Cv of the manufacturer's next larger size. Internal valve trim shall be Type 316 stainless steel.

2.5.9 Valves for High-Temperature Hot-Water Service

Valves for high-temperature hot-water service above 250 Degrees F shall be as follows: Valve bodies shall be rated Class 300, in accordance with ASME B16.34. Valve and actuator combination shall be normally closed. Bodies shall be carbon steel, globe type with welded ends on valves 1 inch and larger. Valves smaller than 1 inch shall have socket-weld ends. Packing shall be virgin polytetrafluoroethylene (PTFE). Valve Cv shall be within 100 percent to 125 percent of the Cv shown. Internal valve trim shall be Type 316 stainless steel.

2.6 DAMPERS

****

NOTE: If the design of the HVAC system does not include smoke dampers, delete paragraph Smoke Dampers. Check damper locations shown against the expected velocity profile to ensure that the maximum velocity of the profile (not average velocity) does not exceed the specified damper velocity limitations.

****

2.6.1 Damper Assembly

A single damper section shall have blades no longer than 48 inches and shall be no higher than 72 inches. Maximum damper blade width shall be 8 inches. Larger sizes shall be made from a combination of sections. Dampers shall be steel, or other materials where shown. Flat blades shall be made rigid by folding the edges. All blade-operating linkages shall be within the frame so that blade-connecting devices within the same damper section will not be located directly in the air stream. Damper axles shall be 0.5 inch (minimum) plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings. Pressure drop through dampers shall not exceed 0.04 inch water gauge at 1,000 fpm in the wide-open position. Frames shall not be less than 2 inches in width. Dampers shall be tested in accordance with AMCA 500-D.

2.6.1.1 Operating Links

Operating links external to dampers (such as crankarms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers) shall withstand a load equal to at least twice the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crankarms shall control the open and closed positions of dampers.

2.6.1.2 Damper Types

Dampers shall be parallel blade type.

2.6.2 Outside-Air, Return-Air, and Relief-Air Dampers

The dampers shall be provided where shown. Blades shall have interlocking edges and shall be provided with compressible seals at points of contact. The channel frames of the dampers shall be provided with jamb seals to minimize air leakage. Dampers shall not leak in excess of 20 cfm per square foot at 4 inches water gaugestatic pressure when closed. Seals shall be suitable for an operating temperature range of minus 40 to plus 200 degrees F. Dampers shall be rated at not less than 2000 fpm air velocity.

2.6.3 Mechanical and Electrical Space Ventilation Dampers

The dampers shall be as shown. Dampers shall not leak in excess of 80 cfm per square foot at 4 inches water (gauge) static pressure when closed. Dampers shall be rated at not less than 1500 fpm air velocity.

2.6.4 Smoke Dampers

Smoke-damper and actuator assembly required per NFPA 90A shall meet the Class II leakage requirements of UL 555S. Dampers shall be rated at not less than 2000 fpm air velocity.

2.6.5   Damper End Switches

****
NOTE: If the HVAC system design includes smoke dampers in the return air and fan discharge, or other dampers requiring end switches, show the end switches on schematics and ladder diagrams.
****

Each end switch shall be a hermetically-sealed switch with a trip lever and over-travel mechanism. The switch enclosure shall be suitable for mounting on the duct exterior and shall permit setting the position of the trip lever that actuates the switch. The trip lever shall be aligned with the damper blade.

2.7   DUCT SMOKE DETECTORS

****
NOTE: Duct detectors are intended to shut down air distribution fans and smoke dampers if provided. Each detector will be indicated on the schematic and associated ladder diagram. When duct smoke detectors which are remote from the associated fan(s) are required, such as those required in air systems over 7 cubic meters/ second (15,000 cfm) serving more than one story, the location of all duct detectors shall be indicated on the plans as well as on the schematic and ladder diagrams.

When the building is equipped with a fire alarm system, the detectors will be connected to the fire alarm control panel (FACP) for alarm initiation. Drawings will indicate wiring to the fire alarm control panel. For existing alarm systems, the designer must detail the connection to the FACP. Duct mounted smoke detectors will need auxiliary contacts to interface with HVAC Control Panel. Coordinate with Section 16721, FIRE DETECTION AND ALARM SYSTEM.
****

Duct smoke detectors shall conform to the requirements of UL 268A. Duct smoke detectors shall have perforated sampling tubes extended into the air duct. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors shall have manual reset. Detectors shall be rated for air velocities that include air flows between [500 and 4000 fpm] [[_____] and [_____] fpm]. Detectors shall be powered from the HVAC control panel. Detectors shall have two sets of normally open alarm contacts and two sets of normally closed alarm contacts. [Detectors shall be connected to the building fire alarm panel for alarm initiation.] A remote annunciation lamp and accessible remote reset switch shall be provided for duct detectors that are mounted eight feet or more above the finished floor and for detectors that are not readily visible. Remote lamps and switches as well as each affected fan unit shall be properly identified in etched rigid plastic placards.

2.8 INSTRUMENTATION

2.8.1 Measurements

Transmitters shall be factory calibrated to provide an output of 4 to 20 mAdc over the indicated ranges:

a. Conditioned space temperature, from 50 to 85 degrees F.

b. Duct temperature, from 40 to 140 degrees F except that return-air temperature for economizer operation shall be minus 30 to plus 130 degrees F.

c. High-temperature hot-water temperature, from 200 to 500 degrees F.

d. Chilled-water temperature, from 30 to 100 degrees F.

e. Dual-temperature water, from 30 to 240 degrees F.

f. Heating hot-water temperature, from 50 to 250 degrees F.

g. Condenser-water temperature, from 30 to 130 degrees F.

h. Outside-air temperature, from minus 30 to 130 degrees F.

i. Relative humidity, 0 to 100 percent for space and duct high-limit applications.

j. Differential pressure for VAV supply-duct static pressure from 0 to 2.0 inches water (gauge).

k. Pitot-tube air-flow measurement station and transmitter, from 0 to 0.1 inch water (gauge) for flow velocities of 700 to 1200 fpm, 0 to 0.25 inch water (gauge) for velocities of 700 to 1800 fpm, or 0 to 0.5 inch water (gauge) for velocities of 700 to 2500 fpm.

l. Electronic air-flow measurement station and transmitter, from 125 to 2500 fpm.

2.8.2 Temperature Instruments

2.8.2.1 Resistance Temperature Detectors (RTD)

Temperature sensors shall be 100 ohms 3- or 4-wire RTD. Each RTD shall be platinum with a tolerance of plus or minus 0.54 degrees F at 32 degrees F with a temperature coefficient of resistance (TCR) of 0.00214ohmn/ohm/degF. Each RTD shall be furnished with an RTD transmitter as specified, integrally-mounted unless otherwise shown.

2.8.2.2 Continuous-Averaging RTD

Continuous-averaging RTDs shall have a tolerance of plus or minus 1.0 degree F at the reference temperature, and shall be of sufficient length to ensure that the resistance represents an average over the cross-section in which it is installed. The sensing element shall have a bendable copper sheath. Each averaging RTD shall be furnished with an RTD transmitter as specified, to match the resistance range of the averaging RTD.

2.8.2.3 RTD Transmitter

The RTD transmitter shall accept a 3-wire 100 ohm RTD input. The transmitter shall be a 2-wire, loop-powered device. The transmitter shall produce a linear 4-to-20 mAdc output corresponding to the required temperature measurement. The output error shall not exceed 0.1 percent of the calibrated span. The transmitter shall include offset and span adjustments.

2.8.3 Relative-Humidity Instruments

A relative-humidity instrument for indoor application shall have a measurement range from 0 to 100 percent relative-humidity and be rated for operation at ambient air temperatures within the range of 25 to 130 degrees F. It shall be capable of being exposed to a condensing air stream (100 percent RH) with no adverse effect to the sensor's calibration or other harm to the instrument. The instrument shall be of the wall-mounted or duct-mounted type, as required by the application, and shall be provided with any required accessories. Instruments used in duct high-limit applications shall have a bulk polymer resistive sensing element. Duct-mounted instruments shall be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage. The instrument (sensing element and transmitter) shall be a 2-wire, loop-powered device and shall have an accuracy of plus or minus 3 percent of full scale within the range of 20 to 80 percent relative humidity. The instrument shall have a typical long-term stability of 1 percent or less drift per year. The transmitter shall convert the sensing element's output to a linear 4-20 mAdc output signal in proportion to the measured relative-humidity value. The transmitter shall include offset and span adjustments.

2.8.4 Electronic Air-Flow-Measurement Stations and Transmitters

2.8.4.1 Stations

Each station shall consist of an array of velocity sensing elements and an air-flow straightener. Air-flow straighteners shall be contained in a flanged sheet-metal or aluminum casing. The velocity sensing elements shall be of the RTD or thermistor type, producing a temperature compensated output. The sensing elements shall be distributed across the duct cross-section in the quantity and pattern specified by the published application data of the station manufacturer. The resistance to airflow through the air-flow measurement station shall not exceed 0.08 inch water gauge at an air-flow of 2,000 fpm. Station construction shall be suitable for operation at air-flows of up to 5,000 fpm over a temperature range of 40 to 120 degrees F, and accuracy shall be plus or minus 3 percent over a range of 125 to 2,500 fpm. In outside-air measurement or in low-temperature air delivery applications, the station shall be certified by the manufacturer to be accurate as specified over a temperature range of minus 20 to plus 120 degrees F. In outside-air measurement applications, the air-flow straightener shall be constructed of 1/8 inch aluminum honeycomb and the depth of the straightener shall not be less than 1.5 inch.

2.8.4.2 Transmitters

Each transmitter shall produce a linear, 4-to-20 mAdc output corresponding to the required velocity measurement. The output error of the transmitter shall not exceed 0.5 percent of the calibrated measurement. Each transmitter shall have offset and span adjustments.

2.8.5 Pitot-Tube Air-Flow-Measurement Stations and Transmitters

2.8.5.1 Pitot-Tube Type Stations

Each station shall contain an array of velocity sensing elements and straightening vanes inside a flanged sheet-metal casing. The velocity sensing elements shall be of the multiple pitot-tube type with averaging manifolds. The sensing elements shall be distributed across the duct cross-section in the quantity and pattern specified by the published installation instructions of the station manufacturer. The resistance to air flow through the air-flow-measurement station shall not exceed 0.08 inch water gauge at an air flow of 2000 fpm. Station construction shall be suitable for operation at air flows of up to 5000 fpm over a temperature range of 40 to 120 F, and accuracy shall be plus or minus 3 percent over a range of 700 to 2500 fpm. This device will not be used if the required velocity measurement is below 700 feet per minute or for outside air flow measurements.

2.8.5.2 Pitot-Tube Type Transmitters

Each transmitter shall produce a linear 4-to-20 mAdc output corresponding to the required velocity pressure measurement. Each transmitter shall have a low-range differential-pressure sensing element and a square-root extractor. Sensing element accuracy shall be plus or minus 1 percent of full scale, and overall transmitter accuracy shall be plus or minus 0.25 percent of the calibrated measurement. Each transmitter shall have offset and span adjustments.

2.8.6 Differential Pressure Instruments

The instrument shall be a pressure transmitter with an integral sensing element. The instrument over pressure rating shall be 300 percent of the operating pressure. The sensor/transmitter assembly accuracy shall be plus or minus 2 percent of full scale. The transmitter shall be a 2-wire, loop-powered device. The transmitter shall produce a linear 4-to-20 mAdc output corresponding to the required pressure measurement. Each transmitter shall have offset and span adjustments.

2.8.7 Thermowells

Thermowells shall be Series 300 stainless steel with threaded brass plug and chain, 2 inch lagging neck and extension-type well, and inside diameter and insertion length as required for the application.

2.8.8 Sunshields

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NOTE: The designer will show locations of the HVAC control panels, and the sunshields for the outside-air temperature sensing elements on the drawings. The HVAC control panels will be located in spaces where the ambient temperature will not exceed 38 degrees C (100 degrees F).

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Sunshields for outside-air temperature sensing elements shall prevent the sun from directly striking the temperature sensing elements. The sunshields shall be provided with adequate ventilation so that the sensing element responds to the ambient temperature of the surroundings. The top of each sunshield shall have a galvanized-metal rainshield projecting over the face of the sunshield. The sunshields shall be painted white or shall be unpainted aluminum.

2.9 THERMOSTATS

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NOTE: Edit these paragraphs depending on whether occupant adjustment capability is required for the room thermostat.

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Thermostat ranges shall be selected so that the setpoint is adjustable [without tools] between plus or minus 10 degrees F of the setpoint shown. Thermostats shall be electronic or electric.

2.9.1 Nonmodulating Room Thermostats

Contacts shall be single-pole double-throw (SPDT), hermetically sealed, and wired to identified terminals. Maximum differential shall be 5 degrees F. Room thermostats shall be enclosed with separate locking covers (guards). Thermostats shall have manual switches as required by the application.

2.9.2 Microprocessor-Based Room Thermostats

Microprocessor-based thermostats shall have built-in keypads for scheduling of day and night temperature settings. When out of the scheduling mode, thermostats shall have continuous display of time, with AM and PM indicator, continuous display of day of week, and either continuous display of room temperature with display of temperature setpoint on demand, or continuous display of temperature setpoint with display of room temperature on demand. In the programmable mode, the display shall be used for interrogating time program ON-OFF setpoints for all 7 days of the week. The time program shall allow 2 separate temperature-setback intervals per day. The thermostats shall have a means for temporary and manual override of the program schedule, with automatic program restoration on the following day. Thermostats shall have a replaceable battery to maintain the timing and maintain the schedule in memory for 1 year in the event of a power outage. Maximum differential shall be 2 degrees F. When used for heat-pump applications, the thermostat shall have an emergency heat switch.

2.9.3 Modulating Room Thermostats

Modulating room thermostats shall have either one output signal, two output signals operating in unison, or two output signals operating in sequence, as required for the application. Each thermostat shall have an adjustable throttling range of 4 to 8 degrees F for each output. Room thermostats shall be enclosed with separate locking covers (guards).

2.9.4 Nonmodulating Capillary Thermostats and Aquastats

Each thermostat shall have a capillary length of at least 5 feet, shall have adjustable direct-reading scales for both setpoint and differential, and shall have a differential adjustable from 3 to 9 degrees C. 6 to 16 degrees F. Aquastats shall be of the strap-on type, with 5 degrees C 10 degrees F fixed differential.

2.9.5 Low-Temperature-Protection Thermostats

Low-temperature-protection thermostats shall be, low-temperature safety thermostats, with NO and NC contacts [and manual reset], with an element length of 20 feet, which shall respond to the coldest 18 inch segment.

2.9.6 Modulating Capillary Thermostats

Each thermostat shall have either one output signal, two output signals operating in unison, or two output signals operating in sequence, as required for the application. Thermostats shall have adjustable throttling ranges of 4 to 8 degrees F for each output.

2.9.7 Fan-Coil Unit Room Thermostats

Fan-coil unit room thermostats in personnel living spaces shall be of the low-voltage type with locking covers. Electrical rating shall not exceed 2.5 amperes at 30 volts ac. Housing shall be corrosion resistant metal or molded plastic. Transformer and fan relay shall be provided for the proper operation of each thermostatic control system as necessary to suit the design of the control system using the thermostats specified below. Either separate heating thermostats and separate cooling thermostats or dual element heating-cooling thermostats may be provided. Motor speed switches shall be provided for 3-speed fan control.

2.9.7.1 Heating Thermostats

Fan-coil heating thermostats shall be provided with fixed heat anticipation and shall have a single-pole, single-throw (SPST) switch hermetically sealed and actuated by a bimetallic or bellows type element. Thermostats shall be provided with external temperature setting devices with a factory set maximum of [72] [68] degrees F. Heating thermostats shall have an adjustable range of at least 13 degrees below [72] [68] degrees F.

2.9.7.2 Cooling Thermostats

Fan-coil cooling thermostats shall be provided with fixed cooling anticipation heater and shall have a single-pole, single-throw (SPST) switch hermetically sealed and actuated by a bimetallic or bellows type element. Thermostats shall be provided with external temperature setting devices with a factory set minimum of 78 degrees F. Cooling thermostats shall have an adjustable range of at least 7 degrees F above 78 degrees F.

2.9.7.3 Dual Element Thermostats

Fan-coil unit combination heating-cooling thermostats shall be provided with separate temperature sensing elements for each system, and shall have a single-pole, single-throw (SPST) switch hermetically sealed and actuated by a bimetallic or bellows type element. Each element shall operate switches to provide single stage control for heating and cooling. Scales and ranges shall be as specified for individual thermostats. Thermostats shall contain, or a subbase shall be provided which contains, selector switches for Heat-Off-Cool. A changeover controller providing automatic summer-winter changeover for thermostats by sensing the supplied fluid temperature shall be provided. A limited range heating-cooling dead band thermostat shall control cooling when temperature is above the upper setpoint and heating when temperature is below the lower setpoint and shall have a dead band, with no heating or cooling, when temperature is between the setpoints. Setpoint adjustment shall be concealed.

2.10 PRESSURE SWITCHES AND SOLENOID VALVES

2.10.1 Pressure Switches

Each switch shall have an adjustable setpoint with visible setpoint scale. Range shall be as shown. Differential adjustment shall span 20 to 40 percent of the range of the device.

2.10.2 Differential-Pressure Switches

Each switch shall be an adjustable diaphragm-operated device with two SPDT contacts, with taps for sensing lines to be connected to duct pressure fittings designed to sense air pressure. These fittings shall be of the angled-tip type with tips pointing into the air stream. The setpoint shall not be in the upper or lower quarters of the range and the range shall not be more than three times the setpoint. Differential shall be a maximum of 0.15 inch water gauge at the low end of the range and 0.35 inch water gauge at the high end of the range.

2.10.3 Pneumatic Electric (PE) Switches

Each switch shall have an adjustable setpoint range of 3 to 20 psig with a switching differential adjustable from 2 to 5 psig. The switch action shall be SPDT.

2.10.4 Solenoid-Operated Pneumatic (EP) Valves

Each valve shall have three-port operation: common, normally open, and normally closed. Each valve shall have an outer cast-aluminum body and internal parts of brass, bronze, or stainless steel. The air connection shall be a 3/8 inch NPT threaded connection. Valves shall be rated for 50 psig when used in a control system that operates at 25 psig or less, or 150 psig when used in a control system that operates in the range of 25 to 100 psig.

2.11 INDICATING DEVICES

2.11.1 Thermometers

2.11.1.1 Piping System Thermometers

Piping system thermometers shall have brass, malleable iron or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 9 inch scale. Thermometers for piping systems shall have rigid stems with straight, angular, or inclined pattern.

2.11.1.2 Piping System Thermometer Stems

Thermometer stems shall have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem shall be filled with a heat-transfer medium.

2.11.1.3 Non-Averaging Air-Duct Thermometers

Air-duct thermometers shall have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism.

2.11.1.4 Averaging Air-Duct Thermometers

Averaging thermometers shall have a 3-1/2 inch (nominal) dial, with black legend on white background, and pointer traveling through a 270-degree arc.

2.11.1.5 Accuracy

Thermometers shall have an accuracy of plus or minus 1 percent of scale range. Thermometers shall have a range suitable for the application.

2.11.2 Pressure Gauges

Gauges shall be 2 inch (nominal) size, back connected, suitable for field or panel mounting as required, shall have black legend on white background, and shall have a pointer traveling through a 270-degree arc. Accuracy shall be plus or minus 3 percent of scale range. Gauges shall meet requirements of ASME B40.1.

2.11.2.1 Pneumatic Actuator Gauges

Field mounted gauges for indicating signal input to pneumatic actuators shall have a scale of 0 to 30 psig with 1 psig graduations.

2.11.2.2 Air Storage Tank, Filter, and Dryer Gauges

Gauges for air storage tanks, or for use before and after dryers or dirt and oil filters, shall have a scale of 0 to 160 psig with 2 psig graduations.

2.11.2.3 Hydronic-System Gauges

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NOTE: The designer will show the required ranges and dial graduations for these gauges where they are applied.

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Gauges for hydronic-system applications shall have ranges and graduations as shown.

2.11.2.4 Control Panel Pressure Gauges

Panel mounted air pressure gauges shall have a scale of 0 to 30 psig with 1 psig graduations.

2.11.3 Low Differential Pressure Gauges

Gauges for low differential-pressure measurements shall be a minimum of 3.5 inch (nominal) size with two sets of pressure taps, and shall have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gauges shall have ranges and graduations as shown. Accuracy shall be plus or minus 2 percent of scale range.

2.12 SINGLE-LOOP CONTROLLERS

2.12.1 Controller Features

The controller shall be a microprocessor-based single-loop device that does not require Contractor generated software. The controller shall be mountable in a panel cutout measuring 3.62 by 3.62 inches. The controller shall have field scalable process variable, a remote setpoint analog input, which is field scalable independent of the process variable, and an analog output with adjustable high and low end limits and proportional control manual reset adjustment. The analog output shall result from proportional, integral and derivative (PID) control. The analog output shall be configurable as direct acting and reverse acting. The controller shall have keyboard, display, auto/manual selection for control of its analog output, remote setpoint adjustment/local setpoint adjustment selection with adjustable high-end and low-end limits, ratio and bias adjustments on remote setpoint input, operator-initiated self-tune/manual-tune selection, anti-reset wind-up feature, and 2 independent SPDT contact-closure outputs (PV alarm and deviation alarm). The controller shall be configurable to power-up in automatic with local setpoint control and in automatic with remote setpoint control. The range of hysteresis adjustment shall be not smaller than from 1 percent to 5 percent of process variable input span. The controller shall power the analog output loop to 20 milliamperes when connected to a load of 600 ohms. The controller shall be capable of retransmitting the process variable to 20 milliamperes when connected to 600 ohms. The controller shall have 5-year battery backup to store operating parameters or shall have nonvolatile memory.

2.12.2 Parameter Input and Display

Control parameters shall be entered and displayed directly, in the correct engineering units, through a series of keystrokes on a front-panel display with a 3-1/2 digit, 7-segment display, with decimal point and polarity indication. The use of this display shall allow manual interrogation of setpoint, mode constants, and values of the process variable and output.

2.12.3 Controller Electrical Requirements

Each controller shall be powered by 120 volts ac. Power consumption shall not be greater than 25 watts. Each controller shall provide electrical noise isolation between the ac power line and the process variable input, remote setpoint input, and output signals and of not less than 100 db at 60 Hz common-mode rejection ratio, and not less than 60 db at 60 Hz normal-mode rejection ratio.

2.12.4 Controller Accuracy

The controller shall have an accuracy of plus or minus 0.30 percent of input span, plus or minus 1 digit.

2.12.5 Self-Tuning

The controller self-tuning operation shall apply proportional, integral, and derivative modes of control and shall modify the mode constants as required. Self-tuning shall only be in operation when selected from the front panel.

2.12.6 Manual-Tuning

The controller manual-tuning operation shall provide proportional, integral, and derivative control modes, or any combination thereof, by means of individual mode constant adjustments. These adjustments shall be set for the appropriate value if a particular control mode action is desired, or to zero if that particular mode is not desired. The proportional-mode constant shall be adjustable from 0 to 200 percent of input signal range, the integral-mode constant shall be adjustable from 0 to 20 repeats per minute, and derivative-mode constant shall be adjustable from 0 to 5 minutes.

2.13 CONTROL DEVICES AND ACCESSORIES

Control device and accessory input impedance shall not exceed 250 ohms.

2.13.1 Function Modules

Function modules shall accept mAdc analog input signals to produce mAdc analog output signals or contact output signals. Modules shall have zero and span adjustments for analog outputs, and setpoint adjustments for contact outputs. Module output span accuracy shall be plus or minus 1 percent of input span. Modules shall be rail-mounted as shown. Power consumption shall be not greater than 5 watts.

2.13.1.1 Minimum-Position Switch and Temperature-Setpoint Device

Minimum-position switch and temperature-setpoint device shall accept a 1000 ohms potentiometer input and shall produce a steady analog output. In temperature setpoint applications the potentiometer shall be single-turn, suitable for wall mounting, enclosed in a locking metal or heavy duty plastic enclosure and shall have a graduated dial corresponding to the range of the setpoint adjustment. In a minimum position switch application the potentiometer shall be mounted on or internal to the minimum position switch. The device shall have its input signal electrically or optically isolated from output. Mounting socket shall be an 8 pin base with pins 1, 2, 3 ac power input, 4, 5, 6 input signal, 7, 8, output signal.

2.13.1.2 Signal-Inverter Modules

Signal inverter shall accept an analog input signal and shall have sufficient output capacity to drive the output signal through a circuit with an impedance of not less than 600 ohms. The output shall be electrically isolated from the input and the device shall have a moisture resistant coating. Mounting socket shall be an 8 pin base with pins 1, 2, 3 ac power input, 4, 5, 6 input signal, 7, 8, output signal.

2.13.1.3 High-Low Signal Selector

High-low signal-selector modules shall accept analog input signals and select either the highest or the lowest input signal as the output signal. The signal selector shall be powered by 120 Vac and the output signal shall be electrically isolated from the input signal.

2.13.1.4 Sequencer Modules (Dual Limit Alarm)

Sequencer modules (dual limit alarms) shall accept an analog input signal and shall provide two contact closure outputs. Each output shall have an adjustable independent contact setpoint with an adjustable switching differential range between 1 percent and 100 percent of the input span. The setpoint shall be adjustable between 0 percent and 100 percent of the input span. Setpoint and switching differential (dead band) adjustment potentiometers shall be internal, top-accessed potentiometers or screws. Sequencers shall return all contacts to their zero input signal condition when power is interrupted. The device shall have moisture resistant coating.

2.13.1.5   Loop Driver Modules

Loop driver module shall accept an analog input signal and shall have a circuit input impedance not greater than 100 ohms. The loop driver module shall have sufficient output capacity to drive the output signal through a circuit with an impedance range of not less than 1000 ohms. The output shall be electrically isolated from the input and the device shall have moisture resistant coating. Mounting socket shall be an 8 pin base with pins 1, 2, 3 ac power input, 4, 5, 6 input signal, 7, 8 output signal.

2.13.2   Relays

Relays shall be 2-pole, double-throw (2PDT) with a 10-ampere resistive rating at 120 Vac, and shall have an enclosed 120-Vac coil with 8 pin blade connectors, and a matching rail-mounted socket. Power consumption shall not be greater than 3 watts.

2.13.3   Time-Delay Relays

Time delay relays shall be 2PDT with 8 pin connectors, dust cover, and a matching rail-mounted socket. Adjustable timing range shall be 0 to 5 minutes. Power consumption shall be not greater than 3 watts.

2.13.4   Current Sensing Relays

Current sensing relays shall provide a normally-open contact rated at a minimum of 50 volts peak and 1/2 ampere or 25 VA, noninductive. There shall be a single hole for passage of current carrying conductors. The devices shall be sized for operation at 50 percent rated current based on the connected load. Voltage isolation shall be a minimum of 600 volts.

2.13.5   Time Clocks

Each time clock shall be a 365-day programmable timing device with 4 independently timed circuits. Each clock shall have a manual scheduling keypad and an alphanumeric display of all timing parameters. Timing parameters shall include: date in Gregorian calendar for month, day and day-of-month indication; and 24-hour time-of-day display, with one-minute resolution for programming the ON and OFF times for each circuit. Each clock shall allow programming of each circuit for 12 holiday periods for either ON or OFF events for any selected duration of the 365-day program. Each clock shall have capacity for programming 4 ON events and 4 OFF events per day for each circuit. The programmed events shall be assignable to a 365-day schedule. Each clock shall have automatic Standard Time and Daylight Saving Time adjustment, by input of the appropriate dates. Each time clock shall have automatic leap year correction. Each clock shall be provided with 4-day battery backup. Power consumption shall not be greater than 10 watts.

2.13.6   Current-to-Pneumatic (IP) Transducers

The transducers shall be 2-wire current-to-pressure transmitters that convert a 4-to-20 mAdc input signal to a 3 to 15 psig, or a 15 to 3 psig, pneumatic output, with a conversion accuracy of plus or minus 2 percent of full scale, including linearity and hysteresis. Input impedance shall not exceed 250 ohms. Air consumption shall not be greater than 0.25 scfm.

2.13.7 Direct Current (DC) Power Supply

One DC power supply shall be used to power all transmitters connected to the control panel. The power supply shall be 24 Vdc at not less than 1.2 amperes, with a peak-to-peak ripple not to exceed 0.03 percent of output voltage. Each power supply shall have a fused input, and shall be protected from voltage surges and powerline transients. The power supply output shall be protected against overvoltage and short circuits.

2.13.8 Power Line Conditioner (PLC)

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Note: A power line conditioner should be included only under certain/extreme circumstances as recommended by an electrical designer.

The designer will indicate the line side voltage available to the controller panel.

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PLCs shall be furnished for each controller panel. The PLCs shall provide both voltage regulation and noise rejection. The PLCs shall be of the ferro-resonant design, with no moving parts and no tap switching, while electrically isolating the secondary from the power line side. The PLCs shall be sized for 125 percent of the actual connected kva load. Characteristics of the PLC shall be as follows:

a. At 85 percent load, the output voltage shall not deviate by more than plus or minus 1 percent of nominal voltage when the input voltage fluctuates between minus 20 percent to plus 10 percent of nominal voltage.

b. During load changes of zero to full load, the output voltage shall not deviate by more than plus or minus 3 percent of nominal voltage. Full correction of load switching disturbances shall be accomplished within 5 cycles, and 95 percent correction shall be accomplished within 2 cycles of the onset of the disturbance.

c. Total harmonic distortion shall not exceed 3-1/2 percent at full load.

2.14 PILOT LIGHTS AND MANUAL SWITCHES

Pilot lights and switches shall be rectangular devices arranged in a horizontal matrix as shown. Momentary switches shall be non-illuminated. Interlocking switches shall have separately illuminated sections. Split legend lights shall have separately illuminated sections. Device illumination shall be by light-emitting diode or neon lamp.

2.15 HVAC SYSTEM CONTROL PANELS

2.15.1 Panel Assembly

The control panel shall be factory assembled and shipped to the job site as a single unit. The panel shall be fabricated as shown, and the devices shall be mounted as shown. Each panel shall be fabricated as a bottom-entry connection point for control-system electric power, control-system main air source, control-system wiring, pneumatic tubing, interconnection of control systems, interconnection of starters and external shutdown devices, and energy monitoring and control systems (EMCS) interface. Each panel shall have an operating temperature rise of not greater than 20 degrees F above an ambient temperature of 100 degrees F.

2.15.2 Panel Electrical Requirements

Each control panel shall be powered by nominal 120 volts ac, fused at 5 amps, terminating at the panel on terminal blocks. Instrument cases shall be grounded. Interior panel, interior door, and exterior panel enclosure shall be grounded.

2.15.3 Enclosure

The enclosure for each panel shall be a NEMA 12 single-door wall-mounted box conforming to NEMA 250, with continuous hinged and gasketed exterior door with print pocket and key lock, continuous hinged interior door, interior back panel, and ventilation louvers in back surface as shown. Inside finish shall be white enamel, and outside finish shall be gray primer over phosphatized surfaces.

2.15.4 Mounting and Labeling

Controllers, pilot lights, switches, IP's, and pressure gauge shall be mounted on the interior door as shown. Power conditioner, fuses and duplex outlet shall be mounted on the interior of the cabinet as shown. All other components housed in the panel shall be mounted on the interior back panel surface of the enclosure, behind the door on rails as shown. Controllers and gauges mounted on the front of the inner door shall be identified by a plastic or metal nameplate as shown that is mechanically attached to the panel. Function modules, relays, timeclocks, IP transducers, DC power supply, and other devices interior to the panel shall be identified by a plastic or metal nameplate that is mechanically attached to the panel. The nameplate shall have the inscription as shown. Lettering shall be cut or stamped into the nameplate to a depth of not less than 1/64 inch, and shall show a contrasting color, produced by filling with enamel or lacquer or by the use of a laminated material. Painting of lettering directly on the surface of the interior door or panel is not permitted.

2.15.5 Wiring and Tubing

2.15.5.1 Current-to-Pneumatic Transducers (IP)

Current-to-pneumatic transducers (IP) shall be piped to bulkhead fittings in the bottom of the panel with a 2 inch loop to accommodate IP replacement and shall be wired to identified terminal blocks.

2.15.5.2 Panel Wiring

Interconnections Wiring shall be installed in wiring ducts in such a way that devices can be added or replaced without disturbing wiring that is not affected by the change. Wiring to all devices shall have a 4 inch wiring loop in the horizontal wiring duct at each wiring connection. There shall be no wiring splices within the control panel. All interconnections required for power or signals shall be made on device terminals or panel terminal blocks, with not more than two wires connected to a terminal.

2.15.5.3 Panel Terminal Blocks

Terminal blocks shall be arranged in groups as shown. Instrument signal grounds at the same ground reference level shall end at a grounding terminal for connection to a common ground point. Wiring-shield grounds at the same reference level shall end at a grounding terminal for connection to a common ground point. Grounding terminal blocks shall be identified by reference level.

2.15.5.4 Wiring Identification

All wiring connected to controllers, time clocks and function modules shall be identified by function and polarity with full word identifiers, i.e., process variable input, remote setpoint input and control output.

2.15.6 EMCS Terminal Blocks

Terminal blocks shall be provided for connections to EMCS as shown. Analog signals shall require only the removal of jumpers to interface to EMCS.

2.16 COMPRESSED-AIR STATIONS

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NOTE: The designer will estimate the required control air consumption to calculate the required motor horsepower of the control air compressor and coordinate with the electrical designer. For hospitals and critical installations, a standby compressor will be provided. For all other applications, the portion covering standby compressor will be deleted. For hospitals, delete the Contractor option permitting the use of polyethylene tubing in lieu of copper. Indicate on the drawings the locations where metallic raceway or electric metallic tubing is not required for protection of nonmetallic tubing.

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2.16.1 Air-Compressor Assembly

The air compressor shall be a high-pressure compressing unit with electric motor. The compressor shall be equipped with a motor with totally enclosed belt guard, an operating-pressure switch, safety-relief valves, gauges, intake filter and intake silencer, and combination type magnetic starter with undervoltage protection and thermal-overload protection for each phase, and shall be supported by a steel base mounted on an air storage tank. The air compressor shall provide the compressed air required for control operation while operating not more than one-third of the time. The air storage tank shall be fabricated for a working pressure of not less than 200 psig, and constructed and certified in accordance with ASME BPV VIII Div 1. The tank shall be of sufficient volume so that no more than six compressor starts per hour are required with the starting pressure switch differential set at 20 psig. The tank shall be provided with an automatic condensate drain trap with manual override feature. [A second (duplex arrangement) compressor of capacity equal to the primary compressor shall be provided, with interlocked control to provide automatic changeover upon malfunction or failure of either compressor. A manual selector switch shall be provided to index the lead compressor including the automatic changeover].

2.16.2 Compressed-Air Station Specialties

2.16.2.1 Refrigerated Dryer, Filters and, Pressure Regulator

A refrigerated dryer shall be provided in the air outlet line of the air storage tank. The dryer shall be of the size required for the full delivery capacity of the compressor. The air shall be dried at a pressure of not less than 70 psig to a temperature not greater than 35 degrees F. The dryer shall be provided with an automatic condensate drain trap with manual override feature. The refrigerant used in the dryer shall be one of the fluorocarbon gases and have an Ozone Depletion Potential of not more than 0.05. A 5 micron prefilter and coalescing-type 0.03 micron oil removal filter with shut-off valves shall be provided in the dryer discharge. Each filter bowl shall be rated for 150 psig maximum working pressure. A pressure regulator, with high side and low side pressure gauges, and a safety valve shall be provided downstream of the filter. Pressure regulators of the relieving type shall not be used.

2.16.2.2 Flexible Pipe Connections

The flexible pipe connectors shall be designed for 150 psig and 250 degrees F service, and shall be constructed of rubber, tetrafluoroethylene resin, or braided corrosion-resistant steel, bronze, monel, or galvanized steel. The connectors shall be suitable for the service intended and may have threaded or soldered ends. The length of the connectors shall be as recommended by the manufacturer for the service intended.

2.16.2.3 Vibration-Isolation Units

The vibration-isolation units shall be standard products with published loading ratings, and shall be single rubber-in-shear, double rubber-in-shear, or spring type.

2.16.2.4 Compressed Air Piping

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NOTE: Delete protective sheath for nonmetallic tubing in concealed, accessible areas not subject to abuse.

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Control air delivered to the system shall conform to ISA S7.0.01. Air lines for pneumatic controls shall be seamless copper tubing or nonmetallic tubing. Copper tubing shall be hard-drawn in exposed areas and either hard-drawn or annealed in concealed areas. Only tool-made bands shall be used. Fittings for copper tubing shall be brass or copper solder joint type except at connections to apparatus, where fittings shall be brass compression type. Nonmetallic tubing shall be compounded from polyethylene, meeting the stress crack test of ASTM D 1693. Nonmetallic individual tube polyethylene or multitube instrument tubing bundle shall be classified as flame retardant under UL 94. The polyethylene material shall be rated as self-extinguishing when tested in accordance with ASTM D 635. Air lines concealed in walls shall be hard-drawn copper tubing or nonmetallic tubing in rigid conduit. Terminal single lines shall be hard-drawn copper tubing, except when the run is less than 12 inches in length, flexible polyethylene may be used. Nonmetallic tubing will not be used for applications where the tubing could be subjected to a temperature exceeding 130 degrees F. Fittings for nonmetallic tubing shall be for instrument service and may be brass or acetal resin of the compression or barbed push-on type.

2.17 ELECTRONIC VARIABLE AIR VOLUME (VAV) TERMINAL UNIT CONTROLS

2.17.1 VAV Terminal Units

The VAV terminal units shall be as specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM. [All VAV terminal box controllers associated with an AHU shall be networked together such that configuration parameters for any controller may be monitored and modified from the controller of any other terminal unit served by the same AHU.]

2.17.2 Terminal-Unit Controls

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NOTE: Edit these paragraphs depending on whether the VAV box is used in conjunction with a duct-mounted heating coil.

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2.17.2.1 Box Control Device

Controls for pressure independent boxes [with recirculating fans] [with series fans] shall consist of a velocity-sensing device in the primary air entering the box, a room temperature sensing element[with occupant setpoint adjustment], a damper actuator, [a duct pressure switch to operate the series fan], and an adjustable microprocessor-based VAV box controller. Each controller shall operate a damper for cooling and heating [and a duct coil for heating.] [and the recirculation fan and duct coil for heating.] Terminal unit controls shall meet the requirements of UL 916 and 47 CFR 15.

2.17.2.2 Communication and Programming Device

One hand-held communication and programming device with instruction manual, plus one additional hand-held communicating device and instruction manual per 100 terminal units, shall be provided. The communication and programming device shall connect to the controller directly [or to a jack at the room-temperature-sensing element location]. The communication and programming device shall be used to read and set minimum velocity, maximum velocity, heating setpoint, and cooling setpoint, and to read velocity and space temperature.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION CRITERIA

The HVAC control system shall be installed and ready for operation, as specified and shown. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be made watertight. The HVAC control system installation shall provide clearance for control system maintenance by maintaining access space between coils, access space to mixed-air plenums, and other access space required to calibrate, remove, repair, or replace control system devices. The control system installation shall not interfere with the clearance requirements for mechanical installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.1 Device Mounting Criteria

Devices mounted in or on piping or ductwork, on building surfaces, in mechanical/electrical spaces, or in occupied space ceilings shall be installed in accordance with manufacturer's recommendations and as shown. Control devices to be installed in piping and ductwork shall be provided with all required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used except as specified.

3.1.2 Wiring Criteria

Wiring external to control panels, including low-voltage wiring, shall be installed in metallic raceways. [Nonmetallic-sheathed cables or metallic-armored cables may be installed in areas permitted by NFPA 70.] Wiring shall be installed without splices between control devices and HVAC control panels. Cables and conductors shall be tagged at both ends, with the identifier shown on the shop drawings, in accordance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Other electrical work shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR and as shown.

3.1.2.1 Power-Line Surge Protection

Equipment connected to ac circuits shall be protected from powerline surges. Equipment protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

3.1.2.2 Surge Protection for Transmitter and Control Wiring

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NOTE: The designer will determine if any additional inputs or outputs require surge protection and will show the requirement for them on the drawings.

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HVAC system control panel equipment shall be protected against surges induced on control and transmitter wiring installed outside and as shown. The equipment protection shall be tested in the normal mode and in the common mode, using the following two waveforms:

a. A 10-microsecond by 1000-microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8-microsecond by 20-microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

3.1.2.3 Controller Output Loop Impedance Limitation

Controller output loops shall be constructed so that total circuit impedance connected to the analog output of a single-loop controller shall not exceed 600 ohms.

3.2 CONTROL SYSTEM INSTALLATION

3.2.1 Damper Actuators

Actuators shall not be mounted in the air stream. Multiple actuators operating a common damper shall be connected to a common drive shaft. Actuators shall be installed so that their action shall seal the damper to the extent required to maintain leakage at or below the specified rate and shall move the blades smoothly.

3.2.2   Local Gauges for Actuators

Pneumatic actuators shall have an accessible and visible receiver gauge installed in the tubing lines at the actuator as shown.

3.2.3   Room-Instrument Mounting

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NOTE: Wall mounted thermostats and similar control system components accessible to the occupants in ADA compliant facilities and spaces must be mounted 1.2 meters (48 inches) above the floor for forward reach and 1.3 meters (54 inches) for side reach. The mounting height and location for these system components must be noted on the drawings or the following paragraph revised accordingly.

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Room instruments, such as wall mounted thermostats, shall be mounted 5 feet above the floor unless otherwise noted. Temperature setpoint device shall be recess mounted.

3.2.4   Smoke Detectors

Duct smoke detectors shall be provided in supply and return air ducts in accordance with NFPA 90A.

3.2.5   Manual Emergency Fan Shutdown Switches

Manual emergency fan shutdown switches shall be provided for air distribution fans in accordance with NFPA 90A. Switches shall be the manual-reset type. Switches shall be located and mounted in an accessible manner, approximately 48 inches above the finished floor. Switches shall be properly identified in etched rigid plastic placards.

3.2.6   Low-Temperature-Protection Thermostats

For each 20 square feet of coil-face area, or fraction thereof, a thermostat shall be provided to sense the temperature at the location shown. The thermostat sensing element shall be installed in a serpentine pattern.

3.2.7   Averaging-Temperature Sensing Elements

Sensing elements shall have a total-element minimum length equal to one linear foot per square foot of duct cross-sectional area.

3.2.8   Foundations and Housekeeping Pads

Foundations and housekeeping pads shall be provided for the HVAC control system air compressors.

3.2.9   Compressed-Air Stations

The air-compressor assembly shall be mounted on vibration eliminators, in accordance with ASME BPV VIII Div 1 for tank clearance. The air line shall be connected to the tank with a flexible pipe connector. Compressed-air-station specialties shall be installed with all required tubing, including condensate tubing to a floor drain.

3.2.10 Duct Static-Pressure Sensing Elements and Transmitters

The duct static-pressure sensing element and transmitter sensing point shall be located at 75% to 100% of the distance between the first and last air terminal units.

3.2.11 Indication Devices Installed in Piping and Liquid Systems

Gauges in piping systems subject to pulsation shall have snubbers. Gauges for steam service shall have pigtail fittings with cock. Thermometers and temperature sensing elements installed in liquid systems shall be installed in thermowells.

3.2.12 Control System Tubing

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NOTE: The designer will show electric or electronic actuators for all outdoor applications.

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The control system shall be installed so that pneumatic lines are not exposed to outside-air temperatures. Air lines shall be concealed except in mechanical rooms and other areas where other tubing and piping is exposed. All tubes and tube bundles exposed to view shall be installed neatly in lines parallel to the lines of the building. Tubing between panels and actuators in mechanical/electrical spaces shall be routed so that the lines are easily traceable. Air lines shall be tested periodically for leaks during installation. Air lines shall be purged of dirt, impurities and moisture before connecting to the control equipment. Air lines shall be number coded or color coded and keyed to the submittal drawings for future identification and servicing the control system.

3.2.12.1 Pneumatic Lines In Mechanical/Electrical Spaces

In mechanical/electrical spaces, pneumatic lines shall be plastic tubing or copper tubing. Horizontal and vertical runs of plastic tubes or soft copper tubes shall be installed in raceways dedicated to tubing. The dedicated raceways shall be supported every 6 feet for horizontal runs and every 8 feet for vertical runs. Tubing not installed in raceways shall be hard-drawn copper tubing with sweat fittings and valves, supported every 6 feet for horizontal runs and every 8 feet for vertical runs.

3.2.12.2 Pneumatic Lines External To Mechanical/Electrical Spaces

Tubing external to mechanical/electrical spaces, when run in plenum ceilings, shall be soft copper with sweat fittings, supported every 8 feet. Tubing not in plenum spaces shall be soft copper with sweat fittings supported every 8 feet or shall be plastic tubing in raceways dedicated to tubing.

3.2.12.3 Connection to Liquid and Steam Lines

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NOTE: The designer will select tubing and fitting

materials appropriate for the ductwork and piping services. Stainless steel tubing will only be used when required for the application such as in corrosive atmospheres.
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Tubing for connection of sensing elements and transmitters to liquid and steam lines shall be [copper] [Series 300 stainless steel] with [brass compression] [stainless-steel compression] fittings.

3.2.12.4   Connection to Ductwork

Tubing for connection of sensing elements and transmitters to ductwork shall be plastic tubing.

3.2.12.5   Tubing in Concrete

Tubing in concrete shall be installed in rigid conduit. Tubing in walls containing insulation, fill, or other packing materials shall be installed in raceways dedicated to tubing.

3.2.12.6   Final Connection to Actuators

Final connections to actuators shall be plastic tubing 12 inches long and unsupported at the actuator.

3.2.12.7   Connection to HVAC Control Panel

A manual valve shall be provided at each HVAC control panel to allow shutoff of main air. Pneumatic connections to HVAC control panels shall be made at bulkhead fittings. Final connections to HVAC control panel bulkhead fitting shall be exposed tubing approximately 12 inches long.

3.3   CONTROL SEQUENCES OF OPERATION

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NOTE: The sequences of operation in this guide specification correspond to the standard systems depicted in TI 810-11. If the control system design deviates from those standard systems in any way, the sequence of operation must be modified accordingly.

Delete sequences of operation for HVAC system types which are not applicable to the project.

Where the sequence is applicable, edit for a specific system, using one edition of the sequence until all such systems are identified and described for the project.

The designer shall determine whether the edited sequences will appear on the contract drawings or in the contract specifications, as required by the design review agency.
****

3.3.1   System Requirements

These requirements shall apply to all primary HVAC systems unless modified herein. The sequences describe the actions of the control system for one direction of change in the HVAC process analog variable, such as temperature, humidity or pressure. The reverse sequence shall occur when the direction of change is reversed.

3.3.1.1 HVAC System Supply Fan Operating

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NOTE: The bracketed sentences and phrases in these paragraphs will be edited according to the control system requirements for interlocked fans, smoke dampers and coil pumps. If a coil circulating pump is used, the designer will describe its operation as a special interlock in the last paragraph of the sequence. If an interlocked exhaust fan is used, the designer will describe its operation as a special interlock in the last paragraph of the sequence.

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HVAC system outside-air, return-air, and relief-air dampers shall function as described hereinafter for specific modes of operation [unless control of the dampers is assumed by the fire and smoke control system. Smoke dampers shall open before fans are allowed to start]. [Interlocked exhaust fans shall be stopped in the unoccupied and ventilation delay modes and their dampers shall be closed. Interlocked exhaust fans shall run in the occupied mode, and their dampers shall open.] Cooling-coil control valves [and cooling-coil circulating pumps] shall function as described hereinafter for the specific modes of operation [unless their control is assumed by the freeze-protection system]. Heating coil valves shall be under control.

3.3.1.2 HVAC System Supply Fan Not Operating

When an HVAC system is stopped, [interlocked fans shall stop,] [the smoke dampers shall close,] the outside-air and relief-air dampers shall close, the return-air damper shall open, all stages of direct-expansion cooling shall stop, the system shall pump down if it has a pump down cycle, humidification shall stop, and cooling-coil valves for coils located indoors shall close to the coil. Cooling-coil valves of units located outdoors shall open to the coil. Heating-coil valves shall remain under control.

3.3.1.3 HVAC System Hydronic Heating Distribution Pump Operation

Hydronic heat-exchanger valves shall be under control.

3.3.1.4 HVAC System Hydronic Heating Distribution Pump Not Operating

Hydronic heat-exchanger valves shall close.

3.3.2 Perimeter-Radiation Control Sequence

A room thermostat, located as shown, shall operate a control valve to maintain the setpoint shown.

3.3.3 Unit-Heater and Cabinet-Unit-Heater

A wall-mounted thermostat with an "AUTO-OFF" switch located as shown, shall cycle the fan to maintain its setpoint as shown when the switch is in the "AUTO" position. When the switch is in the "OFF" position, the fan shall be stopped.

3.3.4 Gas-Fired Infrared-Heater

A microprocessor-based room thermostat with "AUTO-OFF" switch, located as shown, shall control the infrared heater. When the switch is in the "AUTO" position, the thermostat shall cycle the infrared heater to maintain the day and night setpoints as shown. Programmed occupied times shall be considered "day" and programmed unoccupied times shall be considered "night." When the switch is in the "OFF" position, the infrared heater shall be off.

3.3.5 All-Air Small Package Unitary System

A microprocessor-based room thermostat, located as shown, with "HEAT-OFF-COOL" and "AUTO-ON" switches shall control the system. When the switch is in the "HEATING" position, the cooling unit shall be off, and heating shall be active. The thermostat shall operate the condensing unit and system fan to maintain the day and night setpoints as shown. Programmed occupied times shall be considered "day" and programmed unoccupied times shall be considered "night." When the switch is in the "COOLING" position, the heating unit shall be off. The thermostat shall operate the condensing units and system fan to maintain the setpoint as shown during the day. The condensing unit shall be off at night. When the switch is in the "OFF" position, the system shall be off. When the "AUTO-ON" switch is in the "ON" position, the system fan shall run continuously. In the "AUTO" position, the system fan shall operate whenever heating or cooling is required.

3.3.6 Dual-Temperature Fan-Coil Unit

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NOTE: The designer shall revise this paragraph accordingly when two-way valves are used in lieu of three-way valves.

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A wall-mounted thermostat, located as shown, shall cycle the fan to maintain the setpoint as shown. When the fan is on, a three-way valve shall open to the coil. When the fan is off, the three-way valve shall bypass the coil. An aquastat shall switch the wall-mounted thermostat action from heating mode to cooling mode whenever the hydronic dual-temperature medium is below the setpoint shown.

3.3.7 Central Plant Hydronic-Heating with Steam/Hot Water Converter

a. All Modes - The outside-air temperature controller shall accept a signal at its process variable input from a sunshielded outside-air temperature sensing element and transmitter located as shown. The outside-air temperature controller process variable relay contact output shall start and stop pump [_____] at the outside-air temperatures shown. The analog output of the outside-air temperature controller shall send a signal to the remote setpoint input of the primary hydronic-heating system temperature controller to reset the hydronic-heating supply temperature setpoint in a linear schedule based on the outside-air temperature as shown. The hydronic-heating supply temperature controller shall accept a signal at its process variable input from a temperature sensing element and transmitter located in the hydronic-heating supply line and the controller output shall modulate the converter steam control valve to maintain the reset schedule setpoint in the hydronic-heating supply line.

b. Occupied Mode - When the time clock places the system in the occupied mode, a space-temperature sensing element and transmitter located as shown shall signal a space-temperature controller which shall maintain the setpoint as shown by modulating the secondary-hydronic-system zone valve. In this mode of operation, the controller setpoint shall be adjustable from the sensing element and transmitter location.

c. Unoccupied Mode - When the time clock places the system in the unoccupied mode, the setpoint of the controller shall be as shown and shall be adjustable at the HVAC control panel.

3.3.8 Single Building Hydronic Heating with Hot Water Boiler

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NOTE: Designers should be cautious when selecting the lower limit of hot water reset schedule. Selecting a limit too low could result in a return water temperature low enough to cause thermal shock or combustion chamber condensation in the boiler. The use of a constant volume boiler loop as depicted in TI 810-11 essentially eliminates these concerns.

****

a. All Modes - The outside-air temperature controller shall accept a signal at its process variable input from a sunshielded outside-air temperature sensing element and transmitter located as shown. The outside-air temperature controller process variable relay contact output shall start and stop the distribution pump [_____] [, boiler pump [_____],] and boiler [_____] at the outside-air temperatures shown. The analog output of the outside-air temperature controller shall send a signal to the remote setpoint input of the primary hydronic-heating system temperature controller to reset the hydronic-heating supply temperature setpoint in a linear schedule based on the outside-air temperature as shown. The hydronic-heating supply temperature controller shall accept a signal at its process variable input from a temperature sensing element and transmitter located in the hydronic-heating supply line and the controller output shall modulate the hydronic-heating system control valve to maintain the reset schedule setpoint in the hydronic-heating supply line.

b. Occupied Mode - When the time clock places the system in the occupied mode, a space-temperature sensing element and transmitter located as shown shall signal a space-temperature controller which shall maintain the setpoint as shown by modulating the secondary-hydronic-system zone valve. In this mode of operation, the controller setpoint shall be adjustable from the sensor and transmitter location.

c. Unoccupied Mode - When the time clock places the system in the unoccupied mode, the setpoint of the controller shall be as shown and shall be adjustable at the HVAC control panel.

3.3.9 Central Plant High-Temperature Hot-Water Hydronic Heating

a. All Modes - The outside-air temperature controller shall accept a signal at its process variable input from a sunshielded outside-air temperature sensing element and transmitter located as shown. The outside-air temperature controller process variable relay contact output shall start and stop pump [_____] at the outside-air temperatures shown. The analog output of the outside-air temperature controller shall send a signal to the remote setpoint input of the primary hydronic-heating system temperature controller to reset the hydronic-heating supply temperature setpoint in a linear schedule based on the outside-air temperature as shown. The hydronic-heating supply temperature controller shall accept a signal at its process variable input from a temperature sensing element and transmitter located in the hydronic-heating supply line and the controller output shall modulate the converter high-temperature hot-water control valve to maintain the reset schedule setpoint in the hydronic-heating supply line.

b. Occupied Mode - When the time clock places the system in the occupied mode, a space-temperature sensing element and transmitter located as shown shall signal a space-temperature controller which shall maintain the setpoint as shown by modulating the secondary-hydronic-system zone valve. In this mode of operation, the controller setpoint shall be adjustable from the sensing element and transmitter location.

c. Unoccupied Mode - When the time clock places the system in the unoccupied mode, the setpoint of the controller shall be as shown and shall be adjustable at the HVAC control panel.

3.3.10 Central Plant Steam Dual-Temperature Hydronic

Heating and cooling modes shall be manually selected.

a. Heating Mode - When the heating mode is selected, the system changeover valves shall close to the Central Plant chilled water flow and shall open to flow through the converter, the heating pilot light shall turn on, the cooling pilot light shall turn off, and pump [_____] shall be under control of the outside-air temperature controller. The outside-air temperature controller shall accept a signal at its process variable input from a sunshielded outside-air temperature sensing element and transmitter located as shown. The outside-air temperature controller process variable relay contact output shall start and stop pump [_____] at the outside-air temperatures shown. The analog output of the outside-air temperature controller shall send a signal to the remote setpoint input of the primary hydronic-heating system temperature controller to reset the hydronic-heating supply temperature setpoint in a linear schedule based on the outside-air temperature as shown. The hydronic-heating supply temperature controller shall accept a signal at its process variable input from a temperature-sensing element and transmitter located in the hydronic-heating supply line and the controller output shall modulate the converter steam control valve to maintain the reset schedule setpoint in the hydronic-heating supply line.

b. Cooling Mode - When the cooling mode is selected, the converter steam valve shall be closed. Pump [_____] shall continue to operate to circulate water through the system. When the system return-water temperature drops below the setpoint shown, the system-return aquastat shall allow the changeover valves to close to flow through the converter and to open to the central plant chilled-water flow, and place the control of pump [_____] under control of the system time clock, the cooling pilot light shall turn on and the heating pilot light shall turn off. During the occupied mode, pump [_____] shall operate continuously. When the time clock places the control system in the unoccupied mode, pump [_____] shall stop.

3.3.11 Central Plant High-Temperature Hot-Water Dual-Temperature Hydronic

Heating and cooling modes shall be manually selected.

a. Heating Mode - When the heating mode is selected, the system changeover valves shall close to the central plant chilled-water flow and shall open to flow through the converter, the heating pilot light shall turn on, the cooling pilot light shall turn off, and pump [_____] shall be under control of the outside-air temperature controller. The outside-air temperature controller shall accept a signal at its process variable input from a sunshielded outside-air temperature sensing element and transmitter located as shown. The outside-air temperature controller process variable relay contact output shall start and stop pump [_____] at the outside-air temperatures shown. The analog output of the outside-air temperature controller shall send a signal to the remote setpoint input of the primary hydronic-heating system temperature controller to reset the hydronic-heating supply temperature setpoint in a linear schedule based on the outside-air temperature as shown. The hydronic-heating supply temperature controller shall accept a signal at its process variable input from a temperature-sensing element and transmitter located in the hydronic-heating supply line and the controller output shall modulate the converter high-temperature-water control valve to maintain the reset schedule setpoint in the hydronic-heating supply line.

b. Cooling Mode - When the cooling mode is selected, the converter high-temperature-water control valve shall be closed. Pump [_____] shall continue to operate to circulate water through the system. When the system return-water temperature drops below the setpoint shown, the system-return aquastat shall allow the changeover valves to close to flow through the converter and to open to the central plant chilled-water flow, and place the control of pump [_____] under control of the system time clock, the cooling pilot light shall turn on and the heating pilot light shall turn off. During the occupied mode, pump [_____] shall operate continuously. When the time clock places the control system in the unoccupied mode, pump [_____] shall stop.

3.3.12 Single Building Dual-Temperature Hydronic

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NOTE: Designers should be cautious when selecting the lower limit of a hot water reset schedule. Selecting a limit too low could result in a return water temperature low enough to cause thermal shock or combustion chamber condensation in the boiler. In addition, because setpoint reset of system water temperature is achieved by bypassing water around the boiler, damage can occur to constant flow boilers. The use of a constant volume boiler loop as depicted in TI 810-11 essentially eliminates these concerns

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Heating and Cooling Modes shall be manually selected. The position of the dual-temperature changeover valves shall be manually selected.

a. Heating Mode - When the heating mode is selected, chiller [_____] shall be stopped and the cooling pilot light shall turn off. Distribution pump [_____] shall continue to operate until the expiration of a time delay as recommended by the chiller manufacturer. At the expiration of the time delay, the distribution pump [_____] shall be under control of the outside-air temperature controller. The outside-air temperature controller shall accept a signal at its process variable input from a sunshielded outside-air temperature sensing element and transmitter located as shown. On a drop in outside-air temperature below its setpoint, the outside-air temperature controller process variable relay contact output shall start distribution pump [_____]. Starting of distribution pump [_____] shall start boiler [_____], [and boiler pump [_____],] turn on the heating pilot light, and enable control of the hydronic-heating system control valve, once flow through the heating loop is proven by the flow switch. The analog output of the outside-air temperature controller shall send a signal to the remote setpoint input of the primary hydronic-heating system temperature controller to reset the hydronic-heating supply temperature setpoint in a linear schedule based on the outside-air temperature as shown. The hydronic-heating supply temperature controller shall accept a signal at its process variable input from a temperature sensing element and transmitter located in the hydronic-heating supply line and the controller output shall modulate the hydronic-heating system control valve to maintain the reset schedule setpoint in the hydronic-heating supply line.

b. Cooling Mode - When the cooling mode is selected, boiler [_____] [and boiler pump [_____]] shall be stopped, the heating pilot light shall turn off, and control of the hydronic heating system control valve shall be disabled. The distribution pump shall continue to circulate water through the system with the boiler shut off. When the system return-water temperature drops below the setpoint shown, the aquastat shall allow the changeover valves to close to flow through the boiler and to open to flow through the chiller, and place distribution pump [_____] and chiller [_____] under control of the system time clock. During the occupied mode, distribution pump [_____] shall operate continuously, the chiller [_____] shall be permitted to operate, and the cooling pilot light shall be lit. When the timeclock places the control system in the unoccupied mode, chiller [_____] shall shut down and the cooling pilot light shall turn off. Distribution pump [_____] shall continue to operate until the expiration of the time delay.

3.3.13 Heating and Ventilating Sequence

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NOTE: A special interlock control sequence for each fan system will be developed by the designer if required.

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3.3.13.1 Occupied, Unoccupied, and Ventilation-Delay Operating Modes

Ventilation-delay-mode timing shall start prior to the occupied-mode timing. The time clock shall close a contact, which shall turn on the ventilation-delay pilot light and energize a relay which shall prevent the outside-air damper from opening. At the time shown, the time clock shall close a contact which shall turn on the occupied-mode pilot light and shall place the system in the occupied mode. At the expiration of the ventilation-delay-mode timing period, the time clock shall open the contact to turn off the ventilation-delay-mode pilot light and de-energize a relay to allow the outside-air damper to open. At the time shown, the time clock shall open the contact to turn off the occupied-mode pilot light and shall place the control system in the unoccupied mode of operation.

3.3.13.2 Outside-Air, Return-Air, and Relief-Air Dampers

a. Occupied Mode - The outside-air, return-air, and relief-air dampers shall be under space temperature control.

b. Unoccupied and Ventilation-Delay Modes - The dampers shall return to their normal positions.

3.3.13.3 Supply-Fan Control

a. Occupied and Ventilation-Delay Modes - Supply fan [_____] shall start and shall operate continuously.

b. Unoccupied Mode - The supply fan shall cycle from a night-thermostat. The fan shall start at and stop at the setpoints shown.

3.3.13.4 Filter

A differential-pressure switch across the filter shall turn on the filter pilot light when the pressure drop across the filter reaches the setpoint shown.

3.3.13.5 Freeze Protection

All Modes - A freezestat, located as shown, shall stop the supply fan, cause the outside-air, return-air, and relief-air dampers to return to their normal position as shown; and turn on the low-temperature pilot light in the HVAC control panel if the temperature drops below the freezestat's setpoint as shown. Return to the normal mode of operation shall require manual reset at [the freezestat and at] the HVAC control panel.

3.3.13.6 Space Temperature Control

A space-temperature sensing-element and transmitter operating through a space-temperature controller shall first gradually shut off the heating-coil valve. After the heating-coil valve is fully closed, the controller shall then gradually operate the outside-air damper to admit outside air beyond the minimum quantity to maintain the setpoint shown.

3.3.13.7 Emergency Fan Shutdown

Activation of a duct smoke detector in the supply-air or return-air ductwork, or activation of a manual emergency fan shutdown switch shall cause the associated fan to shutdown in accordance with NFPA 90A. Activation of these devices shall operate a pilot light on the HVAC control panel. The panel shall require manual resetting after the detector and the manual switch are reset.

3.3.14 Multizone Control Sequence with Return Fan

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NOTE: In a two-deck multizone system, given that there is no dead band between heating and cooling, reliable operation of the economizer cycle may be difficult to achieve. An economizer cycle should only be used in this system if the unit is either served by a dual-temp hydronic system, or HW and CHW availability is scheduled (i.e.- only HW is available during the heating season and only CHW is available during the cooling season). If HW and CHW are both available year-round, then an economizer cycle should not be used, and the following sequence of operation should be edited accordingly. (See TI 810-11 for further details on this subject.)

****

Multizone control sequence shall consist of the following:

3.3.14.1 Occupied, Unoccupied, and Ventilation-Delay Modes

Ventilation-delay-mode timing shall start prior to the occupied-mode timing. The time clock shall close a contact, which shall turn on the ventilation-delay pilot light and energize a relay which shall prevent the outside-air damper from opening. At the time shown, the time clock shall close a contact which shall turn on the occupied-mode pilot light and shall place the system in the occupied mode. At the expiration of the ventilation-delay-mode timing period, the time clock shall open the contact to turn off the ventilation-delay-mode pilot light and de-energize a relay to allow the outside-air damper to open. At the time shown, the time clock shall open the contact to turn off the occupied-mode pilot light and shall place the control system in the unoccupied mode of operation.

3.3.14.2 Outside-Air, Return-Air, and Relief-Air Dampers

a. Occupied Mode - The outside-air, return-air, and relief-air dampers shall [be under mixed-air temperature and economizer control.] [open to their minimum position.]

b. Unoccupied and Ventilation-Delay Modes - The dampers shall return to their normal positions.

3.3.14.3 Supply-Fan and Return-Fan Control

a. Occupied and Ventilation-Delay Modes - Supply fan [_____] and return fan [_____] shall start, and shall operate continuously.

b. Unoccupied Mode - The supply fan and the return fan shall cycle from a night-thermostat. The fans shall start at and stop at the setpoints shown.

3.3.14.4 Filter

A differential-pressure switch across the filter shall turn on the filter pilot light when the pressure drop across the filter reaches the setpoint shown.

3.3.14.5 Hot-Deck Heating Coil

****

NOTE: Reset of the hot-deck discharge temperature setpoint should not be used in conjunction with outside-air reset of the heating water supply temperature. If the heating water supply temperature setpoint is being reset based on outside-air temperature, delete the bracketed portions of this paragraph.

****

All Modes - [The outside air temperature controller shall accept a signal at its process variable input from a sunshielded outside air temperature sensing element and transmitter located as shown. The analog output of the outside air temperature controller shall send a signal to the remote setpoint input of the heating coil temperature controller to reset the hot-deck temperature setpoint in a linear schedule based on the outside air temperature.] The heating coil temperature controller shall accept a signal at its process variable input from a temperature sensing element and transmitter located in the discharge air of the coil, and the controller output shall modulate the heating coil control valve to maintain the [reset schedule] setpoint shown.

3.3.14.6 Freeze Protection

All Modes - A freezestat, located as shown, shall stop the supply and return fans, cause the outside air, return air, and relief air dampers to return to their normal position as shown, and shall turn on the low-temperature pilot light in the HVAC control panel if the temperature drops below the freezestat's setpoint as shown. Return to the normal mode of operation shall require manual reset [at the freezestat and] at the HVAC control panel.

3.3.14.7 Cold-Deck Coil

a. Occupied and Ventilation-Delay Modes - The control valve shall be modulated by the cooling-coil temperature controller from the signal of a temperature-sensing element and transmitter located in the coil discharge air to maintain the setpoint shown.

b. Unoccupied Mode - The cooling-coil temperature-controller output signal shall be interrupted and the cooling-coil control valve shall be closed.

3.3.14.8 Economizer Control

An economizer controller shall accept the signal of an outside-air temperature-sensing element and transmitter at its process variable input and shall accept the signal of a return-air temperature-sensing element and transmitter at its remote setpoint input. The economizer controller shall perform switch-over between outside-air economizer control mode and minimum outside-air mode. Until the outside-air temperature rises above the setpoint as shown, the economizer controller shall hold the system in the minimum-outside-air mode and the economizer pilot light shall be off. When the outside-air temperature rises above the setpoint, the economizer controller shall place the control system in the economizer mode or in the minimum-outside-air mode as determined by a comparison of the outside-air and return-air temperatures in accordance with the differential temperature setpoints as shown. When the outside-air temperature is low with respect to the return-air temperature, the control system shall be in the economizer mode and the economizer pilot light shall be on. When the economizer controller places the control system in the minimum-outside-air mode, the outside-air damper shall be open to the setting determined by the minimum-position switch.

3.3.14.9 Mixed-Air Temperature Control

****
NOTE: When an economizer cycle is not to be used, delete this paragraph.
****

When the economizer controller places the system in the economizer mode, the mixed-air temperature controller shall modulate the dampers from the signal of a temperature-sensing element and transmitter located in the mixed-air stream to maintain the setpoint shown.

3.3.14.10 Zone-Damper Control

All Modes - A space thermostat for each zone shall gradually operate the zone-mixing damper to heat and cool its respective zone by mixing cold-deck air and hot-deck air to maintain the setpoint as shown. On a rise in space temperature, the hot-deck damper shall gradually close, and the cold-deck damper shall gradually open.

3.3.14.11 Emergency Fan Shutdown

Activation of a duct smoke detector in the supply-air or return-air ductwork, or activation of a manual emergency fan shutdown switch shall cause the associated fan to shutdown in accordance with NFPA 90A. Activation of these devices shall operate a pilot light on the HVAC control panel. The panel shall require manual resetting after the detector and the manual switch are reset.

3.3.15 Dual-Duct Multizone Control Sequence with Return Fan

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NOTE: In a dual-duct multizone system, given that

there is no dead band between heating and cooling, reliable operation of the economizer cycle may be difficult to achieve. An economizer cycle should only be used in this system if the unit is either served by a dual-temp hydronic system, or HW and CHW availability is scheduled (i.e.- only HW is available during the heating season and only CHW is available during the cooling season). If HW and CHW are both available year-round, then an economizer cycle should not be used, and the following sequence of operation should be edited accordingly. (See TI 810-11 for further details on this subject.)

****

3.3.15.1 Occupied, Unoccupied, and Ventilation-Delay Modes

Ventilation-delay mode timing shall start prior to the occupied-mode timing. The time clock shall close a contact, which shall turn on the ventilation-delay pilot light and energize a relay which shall prevent the outside air-damper from opening. At the time shown, the time clock shall close a contact which shall turn on the occupied-mode pilot light and shall place the system in the occupied mode. At the expiration of the ventilation-delay-mode timing period, the time clock shall open the contact to turn off the ventilation-delay-mode pilot light and de-energize a relay to allow the outside-air damper to open. At the time shown, the time clock shall open the contact to turn off the occupied-mode pilot light and shall place the control system in the unoccupied mode of operation.

3.3.15.2 Outside-Air, Return-Air, and Relief-Air Dampers

a. Occupied Mode - The outside-air, return-air, and relief-air dampers shall [be under mixed-air temperature and economizer control.] [open to their minimum position.]

b. Unoccupied and Ventilation-Delay Modes - The dampers shall return to their normal positions.

3.3.15.3 Supply-Fan and Return-Fan Control

a. Occupied and Ventilation-Delay Modes - Supply fan [_____] and return fan [_____] shall start, and shall operate continuously.

b. Unoccupied Mode - The supply fan and the return fan shall cycle from a night-thermostat. The fans shall start and stop at the setpoints shown.

3.3.15.4 Filter

A differential-pressure switch across the filter shall turn on the filter pilot light when the pressure drop across the filter reaches the setpoint shown.

3.3.15.5 Hot-duct Heating Coil

****

NOTE: Reset of the hot-deck discharge temperature setpoint should not be used in conjunction with outside-air reset of the heating water supply

temperature. If the heating water supply temperature setpoint is being reset based on outside-air temperature, delete the bracketed portions of this paragraph.
****

All Modes - [The outside air temperature controller shall accept a signal at its process variable input from a sunshielded outside air temperature sensing element and transmitter located as shown. The analog output of the outside air temperature controller shall send a signal to the remote setpoint input of the heating coil temperature controller to reset the hot-deck temperature setpoint in a linear schedule based on the outside air temperature.] The heating coil temperature controller shall accept a signal at its process variable input from a temperature sensing element and transmitter located in the discharge air of the coil, and the controller output shall modulate the heating coil control valve to maintain the [reset schedule] setpoint shown.

3.3.15.6   Freeze Protection

All Modes - A freezestat, located as shown, shall stop the supply and return fans, cause the outside air, return air, and relief air dampers to return to their normal position as shown, and shall turn on the low-temperature pilot light in the HVAC control panel if the temperature drops below the freezestat's setpoint as shown. Return to the normal mode of operation shall require manual reset [at the freezestat and] at the HVAC control panel.

3.3.15.7   Cold-Duct Cooling Coil

a. Occupied and Ventilation-Delay Modes - The control valve shall be modulated by the cooling-coil temperature controller from the signal of a temperature-sensing element and transmitter located in the coil discharge air to maintain the setpoint shown.

b. Unoccupied Mode - The cooling-coil temperature controller output signal shall be interrupted, and the cooling-coil control valve shall be closed.

3.3.15.8   Economizer Control

****
NOTE: When an economizer cycle is not to be used, delete this paragraph.
****

An economizer controller shall accept the signal of an outside-air temperature-sensing element and transmitter at its process variable input and shall accept the signal of a return-air temperature-sensing element and transmitter at its remote setpoint input. The economizer controller shall perform switchover between outside-air economizer control mode and minimum outside-air mode. Until the outside-air temperature rises above the setpoint as shown, the economizer controller shall hold the system in the minimum-outside-air mode and the economizer pilot light shall be off. When the outside-air temperature rises above the setpoint, the economizer controller shall place the control system in the economizer mode or in the minimum-outside-air mode as determined by a comparison of the outside-air and return-air temperatures in accordance with the differential temperature setpoints as shown. When the outside-air temperature is low with respect to the return-air temperature, the control system shall be in the economizer mode and the economizer pilot light shall be on. When the economizer controller places the control system in the minimum-outside-air mode, the outside-air damper shall be open to the setting determined by the minimum-position switch.

3.3.15.9 Mixed-Air Temperature Control

****

NOTE: When an economizer cycle is not to be used, delete this paragraph.

****

When the economizer controller places the system in the economizer mode, the mixed-air temperature controller shall modulate the dampers from the signal of a temperature-sensing element and transmitter located in the mixed-air stream to maintain the setpoint shown.

3.3.15.10 Dual-Duct Terminal Box

All Modes - The control dampers of the dual-duct box shall modulate in response to the signal of a space thermostat. When the space temperature decreases, the controller shall gradually close the cold-duct damper and shall gradually open the hot-duct damper to maintain the setpoint shown.

3.3.15.11 Emergency Fan Shutdown

Activation of a duct smoke detector in the supply-air or return-air ductwork, or activation of a manual emergency fan shutdown switch shall cause the associated fan to shutdown in accordance with NFPA 90A. Activation of these devices shall operate a pilot light on the HVAC control panel. The panel shall require manual resetting after the detector and the manual switch are reset.

3.3.16 Bypass Multizone Control Sequence with Return Fan

3.3.16.1 Occupied, Unoccupied, and Ventilation-Delay Modes

Ventilation-delay-mode timing shall start prior to the occupied-mode timing. The time clock shall close a contact which shall turn on the ventilation-delay pilot light and energize a relay which shall prevent the outside-air damper from opening. At the time shown, the time clock shall close a contact which shall turn on the occupied-mode pilot light and shall place the system in the occupied mode. At the expiration of the ventilation-delay-mode timing period, the time clock shall open the contact to turn off the ventilation-delay-mode pilot light and de-energize a relay to allow the outside-air damper to open. At the time shown, the time clock shall open the contact to turn off the occupied-mode pilot light and shall place the control system in the unoccupied mode of operation.

3.3.16.2 Outside-Air, Return-Air, and Relief-air Dampers

a. Occupied Mode - The outside-air, return-air, and relief-air dampers shall be under mixed-air temperature and economizer control.

b. Unoccupied and Ventilation-Delay Modes - The dampers shall return to their normal positions.

3.3.16.3 Supply-Fan and Return-Fan Control

a. Occupied and Ventilation-Delay Modes - Supply fan [_____] and return fan [_____] shall start, and shall operate continuously.

b. Unoccupied Mode - The supply fan and the return fan shall cycle from a night-thermostat. The fans shall start at and stop at the setpoints shown.

3.3.16.4 Filter

A differential-pressure switch across the filter shall turn on the filter pilot light when the pressure drop across the filter reaches the setpoint shown.

3.3.16.5 Freeze Protection

All Modes - A freezestat, located as shown, shall stop the supply and return fans, cause the outside air, return air, and relief air dampers to return to their normal position as shown, and shall turn on the low-temperature pilot light in the HVAC control panel if the temperature drops below the freezestat's setpoint as shown. Return to the normal mode of operation shall require manual reset [at the freezestat and] at the HVAC control panel.

3.3.16.6 Cold-Deck Coil

a. Occupied and Ventilation-Delay Modes - The control valve shall be modulated by the cooling-coil temperature controller from the signal of a temperature-sensing element and transmitter located in the coil discharge air to maintain the setpoint shown.

b. Unoccupied Mode - The cooling-coil temperature-controller output signal shall be interrupted and the cooling-coil control valve shall be closed.

3.3.16.7 Economizer Control

An economizer controller shall accept the signal of an outside-air temperature-sensing element and transmitter at its remote setpoint input and shall accept the signal of a return-air temperature-sensing element and transmitter at its process variable input. The economizer controller shall perform switchover between outside-air economizer control mode and minimum outside-air mode. Until the return-air temperature rises above the setpoint as shown, the economizer controller shall hold the system in the minimum-outside-air mode and the economizer pilot light shall be off. When the return-air temperature rises above the setpoint, the economizer controller shall place the control system in the economizer mode or in the minimum-outside-air mode as determined by a comparison of the outside-air and return-air temperatures in accordance with the differential temperature setpoints as shown. When the outside-air temperature is low with respect to the return-air temperature, the control system shall be in the economizer mode and the economizer pilot light shall be on. When the economizer controller places the control system in the minimum-outside-air mode, the outside-air damper shall be open to the setting determined by the minimum-position switch.

3.3.16.8 Mixed-Air Temperature Control

When the economizer controller places the system in the economizer mode, the mixed-air temperature controller shall modulate the dampers from the signal of a temperature-sensing element and transmitter located in the mixed-air stream to maintain the setpoint shown.

3.3.16.9 Zone Control

All Modes - A space thermostat for each zone shall gradually operate the zone-mixing damper and heating coil to heat and cool its respective zone by mixing cold-deck air and bypass-deck air to maintain the setpoint as shown. On a rise in space temperature the heating coil valve shall gradually close, and after a dead band as shown, the bypass damper shall gradually close, and the cold-deck damper shall gradually open.

3.3.16.10 Emergency Fan Shutdown

Activation of a duct smoke detector in the supply-air or return-air ductwork, or activation of a manual emergency fan shutdown switch shall cause the associated fan to shutdown in accordance with NFPA 90A. Activation of these devices shall operate a pilot light on the HVAC control panel. The panel shall require manual resetting after the detector and the manual switch are reset.

3.3.17 Variable Air Volume Control Sequence without Return Fan

3.3.17.1 Occupied, Unoccupied, and Ventilation Delay Modes

Ventilation delay mode timing shall start prior to the occupied mode timing. The time clock shall close a contact, which shall turn on the ventilation delay pilot light and energize a relay which shall prevent the outside air damper from opening, except when under economizer control. At the time shown, the time clock shall close a contact which shall turn on the occupied mode pilot light and shall place the system in the occupied mode. At the expiration of the ventilation delay mode timing period, the time clock shall open the contact to turn off the ventilation delay mode pilot light and de-energize a relay to allow the minimum outside air damper to open. At the time shown, the time clock shall open the contact to turn off the occupied mode pilot light and shall place the control system in the unoccupied mode of operation.

3.3.17.2 Outside Air, Return Air, and Relief Air Dampers

a. Occupied Mode - The economizer outside air, return air, and relief air dampers shall be under mixed air temperature and economizer control. The minimum outside air damper shall be under minimum outside air flow control.

b. Unoccupied Mode - The dampers shall return to their normal positions shown.

c. Ventilation Delay Modes - The minimum outside air damper shall remain closed. The other dampers shall remain in their normal positions as shown, except when under economizer control.

3.3.17.3 Supply Fan Control

a. Occupied and Ventilation Delay Modes - Supply fan [_____] shall start and shall operate continuously.

b. Unoccupied Mode - The supply fan shall cycle from a night thermostat located as shown. The fan shall start at and stop the setpoints shown.

3.3.17.4 Supply Duct Pressurization Control

When the supply fan starts, the duct static pressure controller shall modulate the inlet vanes from the signal of a pressure sensing element and transmitter to maintain the setpoint as shown. A high limit static pressure switch in the fan discharge shall stop the fan and turn on the high static pilot light when the static pressure exceeds the setpoint. Restarting the supply fan and turning off the pilot light shall require manual reset at the HVAC control panel. When the fan is off, the inlet vane shall be closed.

3.3.17.5 Filter

A differential pressure switch across the filter shall turn on the filter pilot light when the pressure drop across the filter reaches the setpoint shown.

3.3.17.6 Freeze Protection

All Modes - A freezestat, located as shown, shall stop the supply fan, cause the outside air, return air, and relief air dampers to return to their normal position as shown, and shall turn on the low temperature pilot light in the HVAC control panel if the temperature drops below the freezestat's setpoint as shown. Return to the normal mode of operation shall require manual reset [at the freezestat and] at the HVAC control panel.

3.3.17.7 Cooling Coil

a. Occupied and Ventilation Delay Modes - The control valve shall be modulated by the cooling coil temperature controller from the signal of a temperature sensing element and transmitter located in the coil discharge air to maintain the setpoint shown.

b. Unoccupied Mode - The cooling coil temperature controller output signal shall be interrupted and the cooling coil control valve shall be closed.

3.3.17.8 Minimum Outside Air Control

a. Occupied Mode - The minimum outside air damper shall be modulated by the outside air flow controller to maintain the minimum outside air flow at setpoint, as sensed by an air flow measurement station located in the minimum outside air duct.

b. Unoccupied and Ventilation Delay Modes - The minimum outside air damper shall remain closed.

3.3.17.9 Economizer Control

An economizer controller shall accept the signal of an outside air temperature sensing element and transmitter at its remote setpoint input and shall accept the signal of a return air temperature sensing element and transmitter at its process variable input. When the return air temperature rises above the setpoint and the outside air temperature is sufficiently below the return air temperature to be effective for cooling, as determined by a comparison of the outside air and return air temperatures in accordance with the differential temperature setpoints, the economizer controller shall place the control system in the economizer mode and turn on the economizer pilot light. When the system is not in economizer mode, the economizer outside air and relief air dampers shall remain closed, the return air damper shall remain open, and the economizer pilot light shall be off.

3.3.17.10   Mixed Air Temperature Control

When the economizer controller places the system in the economizer mode, the mixed air temperature controller shall modulate the economizer outside air, relief air, and the return air dampers to maintain the mixed air temperature at setpoint, as sensed by a temperature sensing element and transmitter located in the mixed air stream as shown. As the economizer outside air and relief air dampers open, the return air damper shall close. When the system is not in economizer mode, the economizer outside air and relief air dampers shall remain closed and the return air damper shall remain open.

3.3.17.11   Pressure Independent Terminal VAV Box

All Modes - The control damper of the VAV box shall modulate in response to the signal from a flow sensing element at the discharge or inlet of the VAV box to a microprocessor-based VAV box velocity controller. The velocity controller shall control the box damper from the minimum flow position to the full flow position from the signal of a space temperature sensing element located as shown. When the space temperature decreases, the damper shall gradually close to the minimum flow position to maintain the cooling setpoint as shown. When the space temperature calls for heating after the minimum flow position is reached, control shall then pass through a temperature dead band as shown. When the space temperature has dropped through the dead band, the duct heater coil shall be gradually controlled to maintain the heating setpoint shown.

3.3.17.12   Fan Powered Terminal VAV Box

a. Series Fan Powered Terminal VAV Box: All Modes - The VAV box fan shall be energized from an upstream duct pressure switch confirming HVAC system fan operation. A space temperature sensing element, located as shown, acting through a microprocessor-based VAV-box controller, shall modulate the supply air control damper, mixing the supply air and recirculating room air to provide a constant volume of air to the space to maintain the cooling set point until the supply air damper closes to minimum supply airflow. When the space temperature calls for heat after the supply air damper is closed to minimum flow and the VAV box is in maximum recirculation, control shall then pass through the temperature dead band as shown. When the space temperature has dropped through the temperature dead band, the duct heater coil shall be gradually controlled to maintain the heating setpoint.

b. Parallel Fan Powered Terminal VAV box: All Modes - A space temperature sensing element, located as shown, acting through a microprocessor-based VAV box controller, shall modulate the supply air control damper to maintain the cooling setpoint until the supply air damper closes to minimum supply airflow. When the space temperature calls for heat after the supply air damper is closed to minimum flow, control shall then pass through the temperature dead band as shown. When the space temperature has dropped through the temperature dead band, the VAV box fan shall be energized. When the space temperature has dropped through a second temperature dead band, the duct heater coil shall be gradually controlled to maintain the heating setpoint.

3.3.17.13 Emergency Fan Shutdown

Activation of a duct smoke detector in the supply air or return air ductwork, or activation of a manual emergency fan, shutdown switch shall cause the associated fan to shut down in accordance with NFPA 90A. Activation of these devices shall operate a pilot light on HVAC control panel. The panel shall require manual resetting after the detector and the manual switch are reset.

3.3.18 Variable Air Volume Control Sequence with Return Fan

3.3.18.1 Occupied, Unoccupied, and Ventilation Delay Modes

Ventilation delay mode timing shall start prior to the occupied mode timing. The time clock shall close a contact, which shall turn on the ventilation delay pilot light and energize a relay which shall prevent the outside air damper from opening, except when under economizer control. At the time shown, the time clock shall close a contact which shall turn on the occupied mode pilot light and shall place the system in the occupied mode. At the expiration of the ventilation delay mode timing period, the time clock shall open the contact to turn off the ventilation delay mode pilot light and de-energize a relay to allow the minimum outside air damper to open. At the time shown, the time clock shall open the contact to turn off the occupied mode pilot light and shall place the control system in the unoccupied mode of operation.

3.3.18.2 Outside Air, Return Air, and Relief Air Dampers

a. Occupied Mode - The economizer outside air, return air, and relief air dampers shall be under mixed air temperature and economizer control. The minimum outside air damper shall be under minimum outside air flow control.

b. Unoccupied Mode - The dampers shall return to their normal positions shown.

c. Ventilation Delay Modes - The minimum outside air damper shall remain closed. The other dampers shall remain in their normal positions as shown, except when under economizer control.

3.3.18.3 Supply Fan and Return Fan Control

a. Occupied and Ventilation Delay Modes - Supply fan [_____] and return fan [_____] shall start and operate continuously.

b. Unoccupied Mode - The supply fan and the return fan shall cycle from a night thermostat. The fans shall start at and stop the setpoints shown.

3.3.18.4 Supply Duct Pressurization Control

When the supply fan starts, the duct static pressure controller shall modulate the inlet vanes from the signal of a pressure sensing element and transmitter to maintain the setpoint shown. A high limit static pressure switch in the fan discharge shall stop the supply fan and the return fan and turn on the high static pilot light when the static pressure exceeds the setpoint. Restarting the supply fan and the return fan and turning off the pilot light shall require manual reset at the HVAC control panel. When the fan is off, the inlet vane shall be closed.

3.3.18.5 Return Fan Volume Control

When the return fan starts, the return fan volume controller shall modulate the return fan inlet vanes, from the signals of an airflow measurement station and transmitter located in the return fan inlet ductwork, and an airflow measurement station and transmitter located in the supply fan outlet ductwork. A constant difference between supply air and return air flow rates shall be maintained as shown.

3.3.18.6 Filter

A differential pressure switch across the filter shall turn on the filter pilot light when the pressure drop across the filter reaches the setpoint shown.

3.3.18.7 Freeze Protection

All Modes - A freezestat, located as shown, shall stop the supply and return fans, cause the outside air, return air, and relief air dampers to return to their normal position, and shall turn on the low temperature pilot light in the HVAC control panel if the temperature drops below the freezestat's setpoint. Return to the normal mode of operation shall require manual reset [at the freezestat and] at the HVAC control panel.

3.3.18.8 Cooling Coil

a. Occupied and Ventilation Delay Modes - The control valve shall be modulated by the cooling coil temperature controller from the signal of a temperature sensing element and transmitter located in the coil discharge air to maintain the setpoint shown.

b. Unoccupied Mode - The cooling coil temperature controller output signal shall be interrupted and the cooling coil control valve shall be closed.

3.3.18.9 Minimum Outside Air Control

a. Occupied Mode - The minimum outside air damper shall be modulated by the outside air flow controller to maintain the minimum outside air flow at setpoint, as sensed by an air flow measurement station located in the minimum outside air duct.

b. Unoccupied and Ventilation Delay Modes - The minimum outside air damper shall remain closed.

3.3.18.10 Economizer Control

An economizer controller shall accept the signal of an outside air temperature sensing element and transmitter at its remote setpoint input and shall accept the signal of a return air temperature sensing element and transmitter at its process variable input. When the return air temperature rises above the setpoint and the outside air temperature is sufficiently below the return air temperature to be effective for cooling, as determined by a comparison of the outside air and return air temperatures in accordance with the differential temperature setpoints, the economizer controller shall place the control system in the economizer mode and turn on the economizer pilot light. When the system is not in economizer mode, the economizer outside air and relief air dampers shall remain closed, the return air damper shall remain open, and the economizer pilot light shall be off.

3.3.18.11   Mixed Air Temperature Control

When the economizer controller places the system in the economizer mode, the mixed air temperature controller shall modulate the economizer outside air, relief air, and the return air dampers to maintain the mixed air temperature at setpoint, as sensed by a temperature sensing element and transmitter located in the mixed air stream, as shown. As the economizer outside air and relief air dampers open, the return air damper shall close. When the system is not in economizer mode, the economizer outside air and relief air dampers shall remain closed and the return air damper shall remain open.

3.3.18.12   Pressure Independent Terminal VAV Box

All Modes - The control damper of the VAV box shall modulate in response to the signal from a flow sensing element at the discharge or inlet of the VAV box to a microprocessor-based VAV box velocity controller. The velocity controller shall control the box damper from the minimum flow position to the full flow position from the signal of a space temperature sensing element located as shown. When the space temperature decreases, the damper shall gradually close to the minimum flow position to maintain the cooling setpoint. When the space temperature calls for heating after the minimum flow position is reached, control shall then pass through a temperature dead band, as shown. When the space temperature has dropped through the dead band, the duct heater coil shall be gradually controlled to maintain the heating setpoint.

3.3.18.13   Fan Powered Terminal VAV Box

a. Series Fan Powered Terminal VAV Box: All Modes - The VAV box fan shall be energized from an upstream duct pressure switch confirming HVAC system fan operation. A space temperature sensing element, located as shown, acting through a microprocessor-based VAV box controller, shall modulate the supply air control damper, mixing the supply air and recirculating room air to provide a constant volume of air to the space to maintain the cooling setpoint until the supply air damper closes to minimum supply airflow. When the space temperature calls for heat after the supply air damper is closed to minimum flow and the VAV box is in maximum recirculation, control shall then pass through the temperature dead band, as shown. When the space temperature has dropped through the temperature dead band, the duct heater coil shall be gradually controlled to maintain the heating setpoint.

b. Parallel Fan Powered Terminal VAV Box: All Modes - A space temperature sensing element, located as shown, acting through a microprocessor-based VAV box controller, shall modulate the supply air control damper to maintain the cooling setpoint until the supply air damper closes to minimum supply airflow. When the space temperature calls for heat after the supply air damper is closed to minimum flow, control shall then pass through the temperature dead band, as shown. When the space temperature has dropped through the temperature dead band, the VAV box fan shall be energized. When the space temperature has dropped through a second temperature dead band, the duct heater coil shall be gradually controlled to maintain the heating setpoint.

3.3.18.14 Emergency Fan Shutdown

Activation of a duct smoke detector in the supply air or return air ductwork, or activation of a manual emergency fan shutdown switch shall cause the associated fan to shut down in accordance with NFPA 90A. Activation of these devices shall operate a pilot light on the HVAC control panel. The panel shall require manual resetting after the detector and the manual switch are reset.

3.3.19 Single-Zone with Hydronic Heating/Cooling Coils No Return Fan

3.3.19.1 Occupied, Unoccupied, and Ventilation-Delay Modes

Ventilation-delay-mode timing shall start prior to the occupied-mode timing. The time clock shall close a contact, which shall turn on the ventilation-delay pilot light and energize a relay which shall prevent the outside-air damper from opening. At the time shown, the time clock shall close a contact which shall turn on the occupied-mode pilot light and shall place the system in the occupied mode. At the expiration of the ventilation-delay-mode timing period, the time clock shall open the contact to turn off the ventilation-delay-mode pilot light and de-energize a relay to allow the outside-air damper to open. At the time shown, the time clock shall open the contact to turn off the occupied-mode pilot light and shall place the control system in the unoccupied mode of operation.

3.3.19.2 Outside-Air, Return-Air, and Relief-Air Dampers

a. Occupied Mode - The outside-air, return-air, and relief-air dampers shall be under space temperature and economizer control.

b. Unoccupied and Ventilation-Delay Modes - The dampers shall return to their normal positions.

3.3.19.3 Supply-Fan Control

a. Occupied and Ventilation-Delay Modes - Supply fan [_____] shall start, and shall operate continuously.

b. Unoccupied Mode - The supply fan shall cycle from a night thermostat. The fan shall start and stop at the setpoints shown.

3.3.19.4 Filter

A differential-pressure switch across the filter shall turn on the filter pilot light when the pressure drop across the filter reaches the setpoint shown.

3.3.19.5 Freeze Protection

All Modes - A freezestat, located as shown, shall stop the supply fan, cause the outside air, return air, and relief air dampers to return to their normal position as shown, and shall turn on the low-temperature pilot light in the HVAC control panel if the temperature drops below the freezestat's setpoint shown. Return to the normal mode of operation shall require manual reset [at the freezestat and] at the HVAC control panel.

3.3.19.6 Hydronic Cooling Coil

a. Occupied and Ventilation-Delay Modes - The control valve shall be modulated by the space-temperature controller.

b. Unoccupied Mode - The space-temperature controller output signal shall be interrupted and the cooling-coil control valve shall be closed.

3.3.19.7 Economizer Control

An economizer controller shall accept the signal of an outside-air temperature-sensing element and transmitter at its remote setpoint input and shall accept the signal of a return-air temperature-sensing element and transmitter at its process variable input. The economizer controller shall perform switchover between outside-air economizer control mode and minimum outside-air mode. Until the return-air temperature rises above the setpoint as shown, the economizer controller shall hold the system in the minimum-outside-air mode and the economizer pilot light shall be off. When the return-air temperature rises above the setpoint, the economizer controller shall place the control system in the economizer mode or in the minimum-outside-air mode as determined by a comparison of the outside-air and return-air temperatures in accordance with the differential temperature setpoints as shown. When the outside-air temperature is low with respect to the return-air temperature, the control system shall be in the economizer mode and the economizer pilot light shall be on. When the economizer controller places the control system in the minimum-outside-air mode, the outside-air damper shall be open to the setting determined by the minimum-position switch.

3.3.19.8 Space-Temperature-Sequenced Heating and Cooling Control

A space-temperature sensing element and transmitter operating through a space-temperature controller shall maintain the setpoint by sequencing the valves and dampers as shown. On a rise in space temperature, the space-temperature controller shall first gradually close the heating-coil valve. After the controller output passes through a dead band, the controller shall then gradually operate the outside-air damper to admit outside air beyond the minimum quantity, except that when the economizer controller places the system in the minimum-outside-air mode, the outside-air damper shall be open to the setting as determined by the minimum-position switch. After the outside-air damper is fully open, upon a further rise in space temperature, the controller shall then gradually open the cooling-coil valve to maintain the setpoint shown.

3.3.19.9 Emergency Fan Shutdown

Activation of a duct smoke detector in the supply-air or return-air ductwork, or activation of a manual emergency fan shutdown switch shall cause the associated fan to shutdown in accordance with NFPA 90A. Activation of these devices shall operate a pilot light on the HVAC control panel. The panel shall require manual resetting after the detector and the manual switch are reset.

3.3.20 Single-Zone with Dual-Temperature Coil; No Return Fan

3.3.20.1 Occupied, Unoccupied, and Ventilation-Delay Modes

Ventilation-delay-mode timing shall start prior to the occupied-mode timing. The time clock shall close a contact, which shall turn on the ventilation-delay pilot light and energize a relay which shall prevent the outside-air damper from opening. At the time shown, the time clock shall close a contact which shall turn on the occupied-mode pilot light and shall place the system in the occupied mode. At the expiration of the ventilation-delay-mode timing period, the time clock shall open the contact to turn off the ventilation-delay-mode pilot light and de-energize a relay to allow the outside-air damper to open. At the time shown, the time clock shall open the contact to turn off the occupied-mode pilot light and shall place the control system in the unoccupied mode of operation.

3.3.20.2 Outside-Air, Return-Air, and Relief-Air Dampers

a. Occupied Mode - The outside-air, return-air, and relief-air dampers shall be under space temperature and economizer control.

b. Unoccupied and Ventilation-Delay Modes - The dampers shall return to their normal positions shown.

3.3.20.3 Supply-Fan Control

a. Occupied and Ventilation-Delay Modes - Supply fan [_____] shall start, and shall operate continuously.

b. Unoccupied Mode - The supply fan shall cycle from a night thermostat. The fan shall start at and stop at the setpoints shown.

3.3.20.4 Filter

A differential-pressure switch across the filter shall turn on the filter pilot light when the pressure drop across the filter reaches the setpoint shown.

3.3.20.5 Freeze Protection

All Modes - A freezestat, located as shown, shall stop the supply fan, cause the outside air, return air, and relief air dampers to return to their normal position as shown, and shall turn on the low-temperature pilot light in the HVAC control panel if the temperature drops below the freezestat's setpoint as shown. Return to the normal mode of operation shall require manual reset [at the freezestat and] at the HVAC control panel.

3.3.20.6 Dual-Temperature Coil Changeover Control

An aquastat, set at the setpoint shown, shall select the heating-season space-temperature controller or the cooling-season space-temperature controller to operate the dual-temperature coil control valve. When hydronic heating is supplied to the dual-temperature coil, the heating-season controller shall be selected to control the dual-temperature control valve as a heating-coil valve in sequence with the outside-air, return-air and relief-air dampers, the heating pilot light shall turn on and the cooling pilot light shall turn off. When hydronic cooling is supplied to the dual-temperature coil, the cooling-season controller shall be selected to operate the dual-temperature control valve as a cooling-coil valve in sequence with outside-air, return-air and relief-air dampers, the cooling pilot light shall turn on and the heating pilot light shall turn off.

3.3.20.7 Dual-Temperature Coil

All Modes - The dual-temperature coil valve shall be modulated by the heating-season controller or by the cooling-season controller as selected.

3.3.20.8 Economizer Control

An economizer controller shall accept the signal of an outside-air temperature-sensing element and transmitter at its remote setpoint input and shall accept the signal of a return-air temperature-sensing element and transmitter at its process variable input. The economizer controller shall perform switchover between outside-air economizer control mode and minimum outside-air mode. Until the return-air temperature rises above the setpoint as shown, the economizer controller shall hold the system in the minimum-outside-air mode and the economizer pilot light shall be off. When the return-air temperature rises above the setpoint, the economizer controller shall place the control system in the economizer mode or in the minimum-outside-air mode as determined by a comparison of the outside-air and return-air temperatures in accordance with the differential temperature setpoints as shown. When the outside-air temperature is low with respect to the return-air temperature, the control system shall be in the economizer mode and the economizer pilot light shall be on. When the economizer controller places the control system in the minimum-outside-air mode, the outside-air damper shall be open to the setting determined by the minimum-position switch.

3.3.20.9 Space-Temperature-Sequenced Heating Control

A space-temperature sensing element and transmitter operating through the heating-season space-temperature controller shall maintain the setpoint by sequencing the dual-temp coil valve and the dampers as shown. On a rise in space temperature, the controller shall first gradually close the coil valve. After the controller output passes through a dead band, the controller shall then gradually operate the outside-air damper to admit outside air beyond the minimum quantity, except that when the economizer controller places the system in the minimum-outside-air mode, the outside-air damper shall be open to the setting as determined by the minimum-position switch.

3.3.20.10 Space-Temperature Sequenced Cooling Control

A space-temperature sensing element and transmitter operating through the cooling-season space-temperature controller shall maintain the setpoint by sequencing the dual-temp coil valve and the dampers as shown. On a rise in space temperature, the controller shall first gradually open the outside-air damper to admit outside-air beyond the minimum quantity, except that when the economizer controller places the system in the minimum-outside-air mode, the outside-air damper shall be open to the setting as determined by the minimum-position switch. When the outside-air damper is fully open, on a further rise in space temperature, the controller shall gradually open the coil valve.

3.3.20.11 Emergency Fan Shutdown

Activation of a duct smoke detector in the supply-air or return-air ductwork, or activation of a manual emergency fan shutdown switch shall cause the associated fan to shutdown in accordance with NFPA 90A. Activation of these devices shall operate a pilot light on the HVAC control panel. The panel shall require manual resetting after the detector and the manual switch are reset.

3.3.21 Single-Zone Control Sequence with Humidity Control; No Return Fan

3.3.21.1 Occupied, Unoccupied, and Ventilation Delay Modes

Ventilation-delay-mode timing shall start prior to the occupied-mode timing. The time clock shall close a contact, which shall turn on the ventilation-delay pilot light and energize a relay which shall prevent the outside-air damper from opening. At the time shown, the time clock shall close a contact which shall turn on the occupied-mode pilot light and shall place the system in the occupied mode. At the expiration of the ventilation-delay-mode timing period, the time clock shall open the contact to turn off the ventilation-delay-mode pilot light and de-energize a relay to allow the outside-air damper to open. At the time shown, the time clock shall open the contact to turn off the occupied-mode pilot light and shall place the control system in the unoccupied mode of operation.

3.3.21.2 Outside-Air Damper

a. Occupied Mode - The outside-air damper shall open.

b. Unoccupied and Ventilation-Delay Modes - The damper shall close.

3.3.21.3 Supply-Fan Control

a. Occupied and Ventilation-Delay Modes - Supply fan [_____] shall start, and shall operate continuously.

b. Unoccupied Mode - The supply fan shall cycle from a night thermostat. The fan shall start and stop at the setpoint shown.

3.3.21.4 Filter

A differential-pressure switch across the filter shall turn on the filter pilot light when the pressure drop across the filter reaches the setpoint shown.

3.3.21.5 Outside-Air Preheat-Coil Control

All Modes - The preheat-coil temperature controller shall modulate the control valve from the signal of a temperature-sensing element and transmitter in the coil discharge air to maintain the setpoint shown.

3.3.21.6 Freeze Protection

All Modes - A freezestat, located as shown, shall stop the supply fan, cause the outside air, return air, and relief air dampers to return to their normal position as shown, and shall turn on the low-temperature pilot light in the HVAC control panel if the temperature drops below the freezestat's setpoint as shown. Return to the normal mode of operation shall require manual reset [at the freezestat and] at the HVAC control panel.

3.3.21.7 Cooling Coil

a. Occupied and Ventilation Delay Modes - A high-signal selector shall compare the outputs from a space-temperature controller and a space- relative-humidity controller and use the highest of the two to modulate the cooling coil control valve.

b. Unoccupied Mode - The high-signal selector output signal shall be interrupted and the cooling coil control valve shall be closed.

3.3.21.8 Humidity Control

a. Occupied Mode - The space-relative-humidity controller shall operate the humidifier control valve and the cooling coil valve. The space-relative-humidity controller shall operate through a signal inverter and a high-signal selector to open the cooling coil valve in the event that the space relative humidity continues to rise after the humidifier valve is closed. The space-relative-humidity controller and a duct high-limit relative-humidity controller shall operate through a low-signal selector to control the humidifier valve. The space-relative-humidity controller shall gradually operate the humidifier valve from the signal of a relative-humidity sensing element and transmitter in the space to maintain the relative-humidity setpoint as shown. The duct high-limit relative-humidity controller shall receive a signal from a relative-humidity sensing element and transmitter in the ductwork downstream of the humidifier and shall limit the relative humidity at that point to a high-limit relative-humidity setpoint shown.

b. Unoccupied and Ventilation-Delay Modes - The signal to the humidifier valve shall be interrupted, and the humidifier valve shall be closed.

3.3.21.9 Constant-Temperature Hydronic-Heating Control

All Modes - A temperature controller shall accept signals from a temperature sensing element and transmitter in the heating supply line, and shall modulate the system control valve to maintain the setpoint shown.

3.3.21.10 Reheat

All Modes - A space thermostat shall gradually close the reheat-coil valve on a rise in space temperature to maintain the setpoint shown.

3.3.21.11 Emergency Fan Shutdown

Activation of a duct smoke detector in the supply-air or return-air ductwork, or activation of a manual emergency fan shutdown switch shall cause the associated fan to shutdown in accordance with NFPA 90A. Activation of these devices shall operate a pilot light on the HVAC control panel. The panel shall require manual resetting after the detector and the manual switch are reset.

3.3.22 Single-Zone - Hydronic Heating and Direct-Expansion Cooling Coils

3.3.22.1 Occupied, Unoccupied, and Ventilation-Delay Modes

Ventilation-delay mode timing shall start prior to the occupied-mode timing. The time clock shall close a contact, which shall turn on the ventilation-delay pilot light and energize a relay which shall prevent the outside-air damper from opening. At the time shown, the time clock shall close a contact which shall turn on the occupied-mode pilot light and shall place the system in the occupied mode. At the expiration of the ventilation-delay-mode timing period, the time clock shall open the contact to turn off the ventilation-delay mode pilot light and de-energize a relay to allow the outside-air damper to open. At the time shown, the time clock shall open the contact to turn off the occupied-mode pilot light and shall place the control system in the unoccupied mode of operation.

3.3.22.2 Outside-Air, Return-Air, and Relief-Air Dampers

a. Occupied Mode - The outside-air, return-air, and relief-air dampers shall be under mixed-air temperature and economizer control.

b. Unoccupied and Ventilation-Delay Modes - The dampers shall return to their normal positions shown.

3.3.22.3 Supply-Fan Control

a. Occupied and Ventilation-Delay Modes - Supply fan [_____] shall start, and shall operate continuously.

b. Unoccupied Mode - The supply fan shall cycle from a night-thermostat. The fan shall start at and stop at the setpoints shown.

3.3.22.4 Filter

A differential-pressure switch across the filter shall turn on the filter pilot light when the pressure drop across the filter reaches the setpoint shown.

3.3.22.5 Freeze Protection

All Modes - A freezestat, located as shown, shall stop the supply fan, cause the outside air, return air, and relief air dampers to return to their normal position as shown, and shall turn on the low-temperature pilot light in the HVAC control panel if the temperature drops below the freezestat's setpoint shown. Return to the normal mode of operation shall require manual reset [at the freezestat and] at the HVAC control panel.

3.3.22.6 Direct Expansion Cooling Coil

a. Occupied and Ventilation-Delay Modes - The stages of cooling shall be operated by the space-temperature controller.

b. Unoccupied Mode - The space-temperature controller output signal shall be interrupted and cooling shall be off.

3.3.22.7 Economizer Control

An economizer controller shall accept the signal of an outside-air temperature-sensing element and transmitter at its remote setpoint input and shall accept the signal of a return-air temperature-sensing element and transmitter at its process variable input. The economizer controller shall perform switchover between outside-air economizer control mode and minimum-outside-air mode. Until the return-air temperature rises above the setpoint shown, the economizer controller shall hold the system in the minimum-outside-air mode and the economizer pilot light shall be off. When the return-air temperature rises above the setpoint, the economizer controller shall place the control system in the economizer mode or in the minimum-outside-air mode as determined by a comparison of the outside-air and return-air temperatures in accordance with the differential temperature setpoints shown. When the outside-air temperature is low with respect to the return-air temperature, the control system shall be in the economizer mode and the economizer pilot light shall be on. When the economizer controller places the control system in the minimum-outside-air mode, the outside-air damper shall be open to the setting determined by the minimum-position switch.

3.3.22.8 Space-Temperature-Sequenced Heating and Cooling Control

A space-temperature sensing element and transmitter operating through a space-temperature controller shall maintain the setpoint by sequencing the heating coil valve, dampers, and stages of DX cooling as shown. On a rise in space temperature, the controller shall first gradually close the heating-coil valve. After the controller output passes through a dead band, the controller shall then gradually operate the outside-air damper to admit outside air beyond the minimum quantity, except that when the economizer controller places the system in the minimum-outside-air mode, the outside-air damper shall be open to the setting as determined by the minimum-position switch. After the outside-air damper is fully open, upon a further rise in space temperature, the controller shall then operate the stages of cooling in sequence to maintain the setpoint shown.

3.3.22.9 Emergency Fan Shutdown

Activation of a duct smoke detector in the supply-air or return-air ductwork, or activation of a manual emergency fan shutdown switch shall cause the associated fan to shutdown in accordance with NFPA 90A. Activation of these devices shall operate a pilot light on the HVAC control panel. The panel shall require manual resetting after the detector and the manual switch are reset.

3.4 COMMISSIONING PROCEDURES

3.4.1 General Procedures

3.4.1.1 Evaluations

The Contractor shall make the observations, adjustments, calibrations, measurements, and tests of the control systems, tune the controllers, set the time clock schedule, and make any necessary control-system corrections to ensure that the systems function as described in paragraph CONTROL SEQUENCES OF OPERATION. The Contractor shall permanently record, on system equipment schedule, the final setting of controller proportional, integral and derivative constant settings, setpoint, manual reset setting, maximum and minimum controller output, and ratio and bias settings, in units and terminology specific to the controller.

3.4.1.2 Item Check

An item-by-item check of the sequence of operation requirement shall be performed using Steps 1 through 4 in the specified control system commissioning procedures. Steps 1, 2, and 3 shall be performed with the HVAC system shutdown; Step 4 shall be performed after the HVAC systems have been started. Signals used to change the mode of operation shall originate from the actual HVAC control device intended for the purpose, such as the time clock. External input signals to the HVAC control panel (such as EMCS, starter auxiliary contacts, and external systems) may be simulated in Steps 1, 2, and 3. With each operational-mode change signal, pilot lights and HVAC-panel output-relay contacts shall be observed to ensure that they function. All terminals assigned to EMCS shall be checked and observed to ensure that the proper signals are available.

3.4.1.3 Weather-Dependent Test Procedures

Weather-dependent test procedures that cannot be performed by simulation shall be performed in the appropriate climatic season. When simulation is used, the Contractor shall verify the actual results in the appropriate season.

3.4.1.4 Configuration

The Contractor shall configure each controller for its specified service.

3.4.1.5 Two-Point Accuracy Check

A two-point accuracy check of the calibration of each HVAC-control-system sensing element and transmitter shall be performed by comparing the HVAC-control-panel readout to the actual value of the variable measured at the sensing element and transmitter or airflow measurement station location. Digital indicating test instruments shall be used, such as digital thermometers, motor-driven psychrometers, and tachometers. The test instruments shall be at least twice as accurate as the specified sensing element-to-controller readout accuracy. The calibration of the test instruments shall be traceable to NIST standards. The first check point shall be with the HVAC system in the shutdown condition, and the second check point shall be with the HVAC system in an operational condition. Calibration checks shall verify that the sensing element-to-controller readout accuracies at two points are within the specified product accuracy tolerances. If not, the device shall be recalibrated or replaced and the calibration check repeated.

3.4.1.6 Insertion, Immersion Temperature

Insertion-temperature and immersion-temperature sensing element and transmitter-to-controller readout calibration accuracy shall be checked at one physical location along the axis of the sensing element.

3.4.1.7 Averaging Temperature

Averaging-temperature sensing element and transmitter-to-controller readout calibration accuracy shall be checked every 2 feet along the axis of the sensing element in the proximity of the sensing element, for a maximum of 10 readings. These readings shall then be averaged.

3.4.1.8 Controller Stations

The Contractor shall use the controllers' MANUAL/AUTOMATIC stations as the means of manipulating control devices, such as dampers and valves, to check IP operation and to effect stable conditions prior to making measurement checks.

3.4.1.9 Controller-Tuning Procedure

The Contractor shall perform a controller-tuning procedure, which shall consist of setting the initial proportional, integral, and derivative (PID) mode constants, controller setpoints, and logging the settings. Tuning shall be self-tuning operation by the controller unless manual tuning is necessary.

3.4.1.10 Controller Manual-Tuning Procedure

Where required, the controller manual-tuning procedure shall be performed in three steps. Using a constant-temperature-setpoint controller as an example, these steps are:

a. Step A:

(1) The controller MANUAL/AUTO station shall be indexed to the AUTO position and the integral- and derivative-mode constants set to zero.

(2) The proportional-mode constant shall be set to an initial setting of 8 percent. (This corresponds to 1.5 psig per degree F or 2.0 ma per degree Fproportional controller output change for a 100 degree F transmitter span.) This causes the controller output signal to vary from live zero output to full output for an input signal change representing an 8 degree F change.

(3) Controllers for other variables, such as relative humidity and static pressure, shall have their proportional-mode constants set initially in a similar manner for an achievable output range proportional to the transmitter span.

b. Step B:

(1) The controller temperature setpoint shall be set at any achievable temperature. The controller output and transmitter input shall be observed.

(2) If the transmitter input continuously oscillates above and below the setpoint without settling at a fixed value, or if such oscillation increases, the proportional-mode constant is too small.

(3) If the proportional-mode constant is too small, increase it in steps until the transmitter input indicates stable control at any temperature, provided that the controller output is not at either extreme of the output range.

(4) If the temperature control point slowly drifts toward or away from the controller setpoint, the proportional-mode constant is too large. Its setting shall be decreased in steps until oscillations occur as described in the preceding paragraphs, and then the setting shall be increased until stable control occurs.

(5) A step change in controller setpoint shall be introduced. This should cause the controller to overshoot the setpoint slightly, with each subsequent overshoot peak value decreasing by a factor of 2/3 until stable control is achieved at, above, or

below the setpoint.

(6) Next, the integral-mode constant setting shall be increased in small steps, and setpoint changes shall be introduced until control point and controller setpoint coincide at stable control. This should happen consistently after a setpoint change within a short time, such as 5 to 10 minutes.

c. Step C:

(1) Unless the HVAC process variable changes rapidly, the derivative-mode constant setting can remain at zero.

(2) If derivative control is needed, the derivative-mode constant shall be gradually increased.

(3) Step changes in controller setpoint shall be introduced, and the derivative-mode constant setting adjusted until stable control is achieved.

3.4.1.11 Setting the Controller

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NOTE: Delete commissioning procedures for system types which are not applicable to the project.

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After the controller manual-tuning procedure is complete, the controller shall be set at the setpoint as shown.

3.4.2 Space-Temperature-Controlled Perimeter Radiation

The heating medium shall be turned on, and the thermostat temperature setpoint shall be raised. The valve shall open. The thermostat temperature shall be lowered and the valve shall close. The thermostat shall be set at the setpoint shown.

3.4.3 Unit Heater and Cabinet Unit Heater

The "OFF/AUTO" switch shall be placed in the "OFF" position. Each space-thermostat temperature setting shall be turned up so that it makes contact to turn on the unit-heater fans. The unit-heater fans shall not start. The "OFF/AUTO" switch shall be placed in the "AUTO" position. The unit-heater fans shall start. Each space-thermostat temperature setting shall be turned down, and the unit-heater fans shall stop. The thermostats shall be set at their temperature setpoints shown. The results of testing of one of each type of unit shall be logged.

3.4.4 Gas-Fired Infrared-Heater

Each space-thermostat temperature setting shall be turned up so that it makes contact to turn on the infrared heater; the heater shall turn on. Each space-thermostat temperature shall be turned down and the infrared heater shall turn off. The thermostats shall be set at their temperature setpoints as shown. The results of testing of one of each type of unit shall be logged.

3.4.5 All-Air Small Packaged Unitary

The schedules shall be manually entered for day-temperature and night-temperature setpoints as shown. The fan "AUTO/ON" switch shall be set to "ON". The time shall be manually entered as "DAY". The heating-cooling switch shall be raised to "HEATING" and cooling shall be off. The temperature setpoint shall be raised and heating shall start. The heating/cooling switch shall be set to "COOLING" and heat shall be off. The temperature setpoint shall be lowered and cooling shall start. The fan "AUTO/ON" switch shall be set to "AUTO" and the foregoing procedure repeated. The fan shall start and stop automatically with the starting and stopping of heating and cooling. The time shall be manually entered as "NIGHT". The foregoing procedures shall be repeated. When the system is verified as operational, the correct "DAY" and "NIGHT" temperature settings shall be restored and the correct time restored. The power to the thermostat shall be shut off and it shall be verified that the thermostat clock keeps time. The results of testing of one of each type of unit shall be logged.

3.4.6 Fan-Coil-Unit

The dual-temperature hydronic system shall be set to heating. Each space thermostat temperature setting shall be turned up so that it makes contact and turns the fan-coil unit on. The fan-coil unit fan shall start and the valves shall open to flow through the coils. Each space thermostat temperature setting shall be turned down and the fan-coil unit fans shall stop. The valves shall close to flow through the coils. The dual-temperature hydronic system shall be switched to cooling. Each space thermostat temperature setting shall be turned up; contact shall be broken and the fan-coil unit fans shall stop. The valves shall close to flow through the coil. Each space thermostat temperature setting shall be turned down. The fan-coil unit fans shall start and the valves shall open to flow through the coils. The thermostats shall be set at the temperature setpoints as shown. The results of testing of one of each type of unit shall be logged.

3.4.7 Central Plant Hydronic-Heating with Steam/Hot Water Converter

Installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The converter valve shall be closed.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air temperature and system-supply temperature shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL". The proper operation of the actuators and positions for all valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:

(1) The outside-air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position and the two-point calibration sensing element-to-controller readout accuracy check for the outside-air temperature performed. The controller proportional band adjustment, the setpoint, the manual reset, and the maximum controller output shall be set to achieve the outside-air temperature schedule as shown.

(2) A signal shall be applied to simulate that the outside-air temperature is above the setpoint as shown. It shall be verified that pump [_____] stops. A signal shall be applied to simulate that the outside-air temperature is below the setpoint as shown. It shall be verified that pump [_____] starts.

(3) The system's supply-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of the sensing element-to-controller readout for the system-supply temperature performed. The controller shall be placed in the remote-setpoint mode. The remote setpoint shall be set for temperature schedule as shown. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller setup and tuning procedures performed. The controller shall be set at a system-supply temperature setpoint within the schedule as shown and the mode-constant setpoints logged. Signals of 8 ma and 16 ma shall be sent to the remote setpoint from the outside-air temperature controller, to verify that the controller setpoint changes to the appropriate values. The outside-air temperature controller's "MANUAL/AUTO" station shall be indexed to "AUTO".

(4) An occupied-mode signal shall be applied. Each space-temperature controller's "MANUAL/AUTO" station shall be indexed to "MANUAL". The calibration accuracy check of sensing element-to-controller readout for each space temperature, shall be performed and the values logged. Each controller shall be placed in the remote-setpoint mode. The setpoint low-end limit shall be set to 66 degrees F and the high-end limit shall be set to 72 degrees F. The proper action of each temperature-setpoint device at the space-temperature sensing element and transmitter location shall be verified. Each controller's "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller-tuning procedure performed. An unoccupied-mode signal shall be applied, and it shall be verified that each controller's setpoint changes to the unoccupied-mode setting. Each temperature setpoint device shall be set to the space-temperature setpoint shown.

3.4.8 Single Building Hydronic-Heating with Hot Water Boiler

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. It shall be verified that power and main air are available at the HVAC system control panel.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air temperature and system-supply temperature shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all valves shall be verified visually. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other. Example: NC actuators are closed at 4 ma [or 3 psig] and are open at 20 ma [or 15 psig]. The signal levels that move the controlled device to its extreme positions shall be logged.

d. Step 4 - Control-System Commissioning:

(1) The outside-air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position and the two-point calibration sensing element-to-controller readout accuracy check for the outside-air temperature performed. The controller proportional band adjustment, the setpoint, the manual reset, and the maximum controller output shall be set to achieve the outside-air temperature schedule shown.

(2) A signal shall be applied to simulate that the outside-air temperature is above the setpoint shown. It shall be verified that pumps [_____] and boiler [_____] stop. A signal shall be applied to simulate that the outside-air temperature is below the setpoint shown. It shall be verified that pumps [_____] start and boiler [_____] operates.

(3) The system's supply-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of the sensing element-to-controller readout for the system-supply temperature performed. The controller shall be placed in the remote-setpoint mode. The remote setpoint for temperature schedule shall be set as shown. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller setup and tuning procedures performed. The controller shall be set at a system-supply temperature setpoint within the schedule as shown and the mode-constant setpoints logged. Signals of 8 ma and 16 ma shall be sent to the remote setpoint from the outside-air temperature controller, to verify that the controller setpoint changes to the appropriate values. The outside-air temperature controller's "MANUAL/AUTO" station shall be indexed to "AUTO."

(4) An occupied-mode signal shall be applied. Each space-temperature controller "MANUAL/AUTO" station shall be indexed to "MANUAL." The calibration accuracy check of sensing element-to-controller readout for each space temperature shall be

performed, and the values logged. The controller shall be placed in the remote-setpoint mode. The setpoint low-end limit shall be set to 66 degrees F and the high-end limit shall be set to 72 degrees F. The proper action of the temperature-setpoint device at the space-temperature sensing element and transmitter location shall be verified. Each controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position and the controller-tuning procedure performed. An unoccupied-mode signal shall be applied and it shall be verified that each controller's setpoint changes to the unoccupied-mode setting. The temperature setpoint device shall be set to the space-temperature setpoint shown.

3.4.9 Central Plant High-Temperature Hot-Water Hydronic-Heating

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The converter valve shall be closed.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air temperature and system-supply temperature shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:

(1) The outside-air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position and the two-point calibration sensing element-to-controller readout accuracy check for the outside-air temperature shall be performed. The controller proportional band adjustment, the setpoint, the manual reset, and the maximum controller output shall be set to achieve the outside-air temperature schedule shown.

(2) A signal shall be applied to simulate that the outside-air temperature is above the setpoint as shown. It shall be verified that pump [_____] stops. A signal shall be applied to simulate that the outside-air temperature is below the setpoint shown. It shall be verified that pump [_____] starts.

(3) The system's supply-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of the sensing

element-to-controller readout for the system-supply temperature shall be performed. The controller shall be placed in the remote-setpoint mode. The remote setpoint shall be set for temperature schedule as shown. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller setup and tuning procedures performed. The controller shall be set at a system-supply temperature setpoint within the range as shown and the mode-constant setpoints logged. Signals of 8 ma and 16 ma shall be sent to the remote setpoint, from the outside-air temperature controller, to verify that the controller setpoint changes to the appropriate values. The outside-air temperature controller's "MANUAL/AUTO" station shall be indexed to "AUTO." A high-temperature condition shall be initiated in the system supply line by lowering the thermostat setting. It shall be verified that the high-temperature hot-water shutoff valve closes and the pilot light turns on. The thermostat shall be set at the setting shown, the safety circuit shall be manually reset, and it shall be verified that the shutoff valve opens and the pilot light turns off.

(4) An occupied-mode signal shall be applied. Each space-temperature controller "MANUAL/AUTO" station shall be indexed to "MANUAL". The calibration accuracy check of sensing element-to-controller readout for each space temperature shall be performed, and the values logged. The controller shall be placed in the remote-setpoint mode. The setpoint low-end limit shall be set to 66 degrees F and the high-end limit shall be set to 72 degrees F. The proper action of the temperature-setpoint device at the space-temperature sensing element and transmitter location shall be verified. Each controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller-tuning procedure shall be performed. An unoccupied-mode signal shall be applied, and it shall be verified that each controller's setpoint changes to the unoccupied-mode setting. The temperature setpoint device shall be set to the space-temperature setpoint shown.

3.4.10 Central Plant Dual-Temperature Hydronic

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The converter valve shall be closed.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air temperature, system-supply temperature, and system-return temperature shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:

(1) The outside-air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position and the two-point calibration sensing element-to-controller readout accuracy check for the outside-air temperature shall be performed. The controller proportional band adjustment, the setpoint, the manual reset, and the maximum controller output shall be set to achieve the outside-air temperature schedule as shown.

(2) The system shall be indexed to the heating mode and it shall be verified that the changeover valves open to flow through the converter and close to flow from central plant chilled water. It shall be verified that the heating pilot light turns on and the cooling pilot light turns off.

(3) A signal shall be applied to simulate that the outside-air temperature is above the setpoint as shown. It shall be verified that pump [_____] stops. A signal shall be applied to simulate that the outside-air temperature is below the setpoint as shown. It shall be verified that pump [_____] starts.

(4) The system's supply-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of the sensing element-to-controller readout for the system-supply temperature shall be performed. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller setup and tuning procedures performed. The controller shall be set at a system-supply temperature setpoint within the schedule as shown and the mode-constant setpoints logged. Signals of 8 ma and 16 ma shall be sent to the remote setpoint from the outside-air temperature controller, to verify that the controller setpoint changes to the appropriate values. The outside-air temperature controller's "MANUAL/AUTO" station shall be indexed to "AUTO."

(5) The return-water aquastat shall be set to the setpoint as shown. An unoccupied-mode signal shall be applied from the system time clock and it shall be verified that the occupied pilot light turns off.

(6) The system shall be indexed to the cooling mode. It shall be verified that the converter control valve closes, the heating pilot light turns off, and that pump [_____] continues to operate until the return-water temperature falls below the setpoint of the return-water aquastat. It shall be verified that when the return-water temperature falls below the setpoint of the return-water aquastat that the changeover valves close to flow through the converter and open to flow from central plant chilled water, that the cooling pilot light turns on and that pump [_____] stops.

(7) An occupied-mode signal shall be applied from the system time

clock and it shall be verified that the occupied pilot light turns on, and pump [_____] starts.

3.4.11 Central Plant High-Temperature Hot-Water Dual-Temperature Hydronic

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The converter control valve shall be closed.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air temperature and system-supply temperature shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:

(1) The outside-air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position and the two-point calibration sensing element-to-controller readout accuracy check for the outside-air temperature shall be performed. The controller proportional band adjustment, the setpoint, the manual reset, and the maximum controller output shall be set to achieve the outside-air temperature schedule as shown.

(2) The system shall be indexed to the heating mode and it shall be verified that the changeover valves open to flow through the converter and close to flow from central plant chilled water. It shall be verified that the heating pilot light turns on and the cooling pilot light turns off.

(3) A signal shall be applied to simulate that the outside-air temperature is above the setpoint as shown. It shall be verified that pump [_____] stops. A signal shall be applied to simulate that the outside-air temperature is below the setpoint as shown. It shall be verified that pump [_____] starts.

(4) The system's supply-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of the sensing element-to-controller readout for the system-supply temperature shall be performed. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller setup and

tuning procedures performed. The controller shall be set at a system-supply temperature setpoint within the schedule as shown and the mode-constant setpoints logged. Signals of 8 ma and 16 ma shall be sent to the remote setpoint from the outside-air temperature controller, to verify that the controller setpoint changes to the appropriate values. The outside-air temperature controller's "MANUAL/AUTO" station shall be indexed to "AUTO."

(5) The return-water aquastat shall be set to the setpoint as shown. An unoccupied-mode signal shall be applied from the system time clock and it shall be verified that the occupied pilot light turns off.

(6) The system shall be indexed to the cooling mode. It shall be verified that the converter control valve closes, the heating pilot light turns off, and that pump [_____] continues to operate until the return-water temperature falls below the setpoint of the return-water aquastat. It shall be verified that when the return-water temperature falls below the setpoint of the return-water aquastat that the changeover valves close to flow through the converter and open to flow from central plant chilled water, that the cooling pilot light turns on and that pump [_____] stops.

(7) An occupied-mode signal shall be applied from the system time clock and it shall be verified that the occupied pilot light turns on, and pump [_____] starts.

3.4.12 Single Building Dual-Temperature Hydronic

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air availability at the HVAC system control panel shall be checked.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air temperature and system-supply temperature shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL". The proper operation of the actuators and positioners for all valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range shall be made. It shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:
(1) The outside-air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position and the two-point calibration sensing element-to-controller readout accuracy check

for the outside-air temperature performed. The controller proportional band adjustment, the setpoint, the manual reset, and the maximum controller output shall be set to achieve the outside-air temperature schedule as shown.

(2) The system shall be indexed to the heating mode and it shall be verified that chiller [_____] is shutdown, and the cooling pilot light turns off. It shall be verified that the changeover valves open to flow through boiler [_____] and close to flow through chiller [_____].

(3) A signal shall be applied to simulate that the outside-air temperature is above the setpoint as shown. It shall be verified that distribution pump [_____] is off, boiler [_____] is stopped, [boiler pump [_____] is stopped,] heating pilot light is turned off, and control of the hydronic-heating system control valve is disabled. A signal shall be applied to simulate that the outside-air temperature is below the setpoint as shown. It shall be verified that distribution pump [_____] starts, boiler [_____] is started, [boiler pump [_____] is started,] heating pilot light is turned on, and control of the hydronic-heating system control valve is enabled.

(4) The system's supply-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of the sensing element-to-controller readout for the system-supply temperature shall be performed. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller setup and tuning procedures performed. The controller shall be set at a system-supply temperature setpoint within the schedule as shown and the mode-constant setpoints logged. Signals of 8 ma and 16 ma shall be sent to the remote setpoint from the outside-air temperature controller, to verify that the controller setpoint changes to the appropriate values. The outside-air temperature controller's "MANUAL/AUTO" station shall be indexed to "AUTO."

(5) The return-water aquastat shall be set to the setpoint as shown. An unoccupied mode signal shall be applied from the system time clock. It shall be verified that the occupied pilot light turns off.

(6) The system shall be indexed to the cooling mode. It shall be verified that boiler [_____] shuts down, [boiler pump [_____] shuts down,] the heating pilot light turns off, and distribution pump [_____] continues to operate until the expiration of the time delay. It shall be verified that when the return-water temperature falls below the setpoint of the return-water changeover aquastat, the changeover valves close to flow through the boiler [_____] and open to flow through chiller [_____].

(7) An occupied-mode signal shall be applied from the system time clock and it shall be verified that the occupied pilot light turns on, distribution pump [_____] starts, and upon proof of flow by the flow switch, chiller operation is enabled and the cooling pilot light turns on.

(8) An unoccupied mode signal shall be applied from the system time clock and it shall be verified that the occupied pilot light

turns off, the cooling pilot light turns off, chiller [_____] shuts down and distribution pump [_____] continues to operate until the expiration of the time delay and then stops.

3.4.13 Heating and Ventilating

Steps for installation are as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside-air damper and relief-air damper shall be closed and the return-air damper shall be open.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for space temperature shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:

(1) With the fan ready to start, the ventilation-delay-mode signal shall be applied, and it shall be verified that the ventilation-delay-mode pilot light turns on. The occupied-mode signal shall be applied and it shall be verified that the occupied-mode pilot light turns on and that supply fan [_____] starts. It shall be verified that the outside-air and relief-air dampers are closed, the return-air damper is open, and the heating-coil valve is under control, by slightly changing the controller outputs. The ventilation-delay-mode signal shall be released, and it shall be verified that the ventilation-delay-mode pilot light turns off and that the outside-air, return-air, and relief-air dampers come under control by changing the controller output.

(2) The minimum-outside-air-mode signal shall be applied. It shall be verified that the outside-air damper opens to minimum position and the economizer pilot light is off.

(3) The space-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check for sensing element-to-controller readout shall be performed. The controller shall be placed in the remote-setpoint mode. The setpoint low-end limit shall be set to 66 degrees F

and the high-end limit shall be set to 72 degrees F. Proper operation of the temperature setpoint device at the space temperature sensing element and transmitter location shall be verified. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position and the controller-tuning procedure shall be performed. The temperature setpoint device shall be set to the space temperature setpoint as shown.

(4) An unoccupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night-thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the setpoint as shown.

(5) With the HVAC system running, a filter differential-pressure switch input signal shall be simulated, at the device. It shall be verified that the filter pilot light turns on, and that contact output at EMCS terminals is made. The differential-pressure switch shall be set at the setpoint as shown.

(6) With the HVAC system running, a freezestat trip input signal shall be simulated, at the device. HVAC system shutdown shall be observed. It shall be verified that the low-temperature pilot light turns on and that contact output at the EMCS terminals is made. The freezestat shall be set at the setpoint as shown. The HVAC shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(7) With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and verification of control-device actions and interlock functions as described in paragraph CONTROL SEQUENCES OF OPERATION shall be made. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke-detector pilot light turns on, and contact output at EMCS terminals shall be verified. The detectors shall be reset. The HVAC system shall be restarted by manual reset, and it shall be verified that the pilot light turns off.

3.4.14 Multizone Control System with Return Fan

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NOTE: For subparagraph d, step 4 below, in a two-deck multizone system, given that there is no dead band between heating and cooling, reliable operation of the economizer cycle may be difficult to achieve. An economizer cycle should only be used in this system if the unit is either served by a dual-temp hydronic system, or HW and CHW availability is scheduled (i.e.- only HW is available during the heating season and vice versa). If HW and CHW are both available year-round, then an economizer cycle should not be used. The following commissioning procedures should be edited accordingly. (See TI 810-11 for further details on

this subject.)

When an economizer cycle is not to be used, delete subparagraph d, step 4, subparagraph (3).

In subparagraph d, step 4, subparagraph (4), outside-air reset of the hot-deck discharge temperature setpoint should not be used in conjunction with outside-air reset of the heating water supply temperature. If outside-air reset of the hot-deck discharge temperature is not being performed, delete this paragraph and the paragraph that follows.

If outside-air reset of the hot-deck discharge temperature is being performed, delete subparagraph d, step 4, subparagraph (6).
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Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside-air and relief-air dampers shall be closed, the return-air damper open, and the cooling-coil valve closed.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air, return-air, mixed-air, cold-deck-air, and hot-deck-air temperatures shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:

(1) With the fans ready to start, the ventilation-delay-mode signal shall be applied, and it shall be verified that the ventilation-delay-mode pilot light turns on. The occupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns on and that supply fan [_____] and return fan [_____] start. It shall be verified that the outside-air and relief-air dampers are closed, the return-air damper is open, and the heating and cooling-coil valves are under

control, by slightly changing the controller outputs. The ventilation-delay-mode signal shall be released, and it shall be verified that the ventilation-delay-mode pilot light turns off, and that the outside-air, return-air, and relief-air dampers come under control, by changing the controller output.

(2) The minimum-outside-air-mode signal shall be applied. It shall be verified that the outside-air damper opens to minimum position [and that the economizer pilot light is off].

(3) The mixed-air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position. An economizer-mode input signal shall be simulated and it shall be verified that the economizer-mode pilot light turns on. The mixed-air temperature controller output shall be changed to slightly open the outside-air damper and the second point of the two-point calibration accuracy check of sensing element-to-controller readout for outside-air, return-air, and mixed-air temperatures shall be performed. The controller-tuning procedure shall be performed. The mixed-air temperature controller "MANUAL/AUTO" switch shall be indexed to the "AUTO" position. The mixed-air temperature controller shall be placed in the local setpoint mode and set at the temperature setpoint as shown.

(4) The outside-air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position and the two-point calibration sensing element-to-controller readout accuracy check for the outside-air temperature shall be performed. The controller proportional band adjustment, the setpoint, the manual reset, and the maximum controller output shall be set to achieve the outside-air temperature schedule as shown.

(5) The hot-deck temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of sensing element-to-controller readout for outside-air and hot-deck temperatures shall be performed. The controller shall be placed in the remote-setpoint mode. The remote setpoint shall be set for [_____] degrees F at 20-ma input and [_____] degrees F at 4-ma input. Send a 12-ma signal to the remote setpoint for tuning at midrange. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller-tuning procedure performed. Three signals shall be applied simulating outside-air temperature changes. The signals shall be selected at midrange, lower 1/3 range, and upper 1/3 range of the temperature schedule. It shall be verified that the hot-deck temperature controller setpoint tracks the schedule. The hot-deck temperature controller setpoint shall be set for the existing outside-air temperature as shown.

(6) The hot-deck temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of sensing element-to-controller readout shall be performed. The controller shall be placed in the local-setpoint mode, and set at the temperature setpoint as shown. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller-tuning procedure performed.

(7) The cold-deck temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration

accuracy check of sensing element-to-controller readout shall be performed. The controller shall be placed in the local-setpoint mode, and set at the temperature setpoint as shown. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller-tuning procedure performed.

(8) An unoccupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night-thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the setting as shown.

(9) With the HVAC system running, a filter differential-pressure switch input signal shall be simulated at the device. It shall be verified that the filter pilot light turns on, and that contact output at the EMCS terminals is made. The differential-pressure switch shall be set at the setpoint as shown.

(10) With the HVAC system running, a freezestat trip input signal shall be simulated at the device. HVAC system shutdown shall be observed. It shall be verified that the low-temperature pilot light turns on, and that contact output at the EMCS terminals is made. The freezestat shall be set at the setpoint as shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(11) With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and control-device actions and interlock functions, as described in paragraph CONTROL SEQUENCES OF OPERATION, shall be verified. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke-detector pilot light turns on, and contact output at the EMCS terminals is made. The detectors shall be reset. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(12) The setpoint of each zone thermostat shall be raised and it shall be verified that the zone damper closes to the cold deck and opens to the hot deck. The thermostat of each zone shall be calibrated and set at its setpoint as shown.

3.4.15 Dual-Duct Multizone Control System with Return Fan

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NOTE: For subparagraph d, step 4 below, in a two-deck multizone system, given that there is no dead band between heating and cooling, reliable operation of the economizer cycle may be difficult to achieve. An economizer cycle should only be used in this system if the unit is either served by a dual-temp hydronic system, or HW and CHW availability is scheduled (i.e.- only HW is available during the heating season and vice versa). If HW and CHW are both available year-round, then

an economizer cycle should not be used. The following commissioning procedures should be edited accordingly. (See TI 810-11 for further details on this subject.)

When an economizer cycle is not to be used, delete subparagraph d, step 4, subparagraph (3).

In subparagraph d, step 4, subparagraph (4), outside-air reset of the hot-deck discharge temperature setpoint should not be used in conjunction with outside-air reset of the heating water supply temperature. If outside-air reset of the hot-deck discharge temperature is not being performed, delete this paragraph and the paragraph that follows.

If outside-air reset of the hot-deck discharge temperature is being performed, delete subparagraph d, step 4, subparagraph (6).
****

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside-air and relief-air dampers shall be closed, the return-air damper open, and the cooling-coil valve closed.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air, return-air, mixed-air, cold-duct-air, and hot-duct-air temperatures shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:

(1) With the fans ready to start, the ventilation delay mode signal shall be applied, and it shall be verified that the ventilation-delay-mode pilot light turns on. The occupied-mode signal shall be applied, and it shall be verified that the

occupied-mode pilot light turns on and that supply fan [_____] and return fan [_____] start. It shall be verified that the outside-air and relief-air dampers are closed, the return-air damper is open, and the heating and cooling-coil valves are under control, by slightly changing the controller outputs. The ventilation-delay-mode signal shall be released, and it shall be verified that the ventilation-delay-mode pilot light turns off and the outside-air, return-air, and relief-air dampers come under control by changing the controller output.

(2) The minimum-outside-air-mode signal shall be applied. It shall be verified that the outside-air damper opens to minimum position [and that the economizer pilot light is off].

(3) The mixed-air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position. An economizer-mode input signal shall be simulated and it shall be verified that the economizer-mode pilot light turns on. The mixed-air temperature controller output shall be changed to slightly open the outside-air damper and the second point of the two-point calibration accuracy check of sensing element-to-controller readout for outside-air, return-air, and mixed-air temperatures shall be performed. The controller-tuning procedure shall be performed. The mixed-air temperature controller "MANUAL/AUTO" switch shall be indexed to the "AUTO" position. The mixed-air temperature controller shall be placed in the local setpoint mode and set at the temperature setpoint as shown.

(4) The outside-air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position and the two-point calibration sensing element-to-controller readout accuracy check for the outside-air temperature shall be performed. The controller proportional band adjustment, the setpoint, the manual reset, and the maximum controller output shall be set to achieve the outside-air temperature schedule as shown.

(5) The hot-deck temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of sensing element-to-controller readout for outside-air and hot-deck temperatures shall be performed. The controller shall be placed in the remote-setpoint mode. The remote setpoint shall be set for [_____] degrees F at 20-ma input and [_____] degrees F at 4-ma input. Send a 12-ma signal to the remote setpoint for tuning at midrange. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller-tuning procedure performed. Three signals shall be applied simulating outside-air temperature changes. The signals shall be selected at midrange, lower 1/3 range, and upper 1/3 range of the temperature schedule. It shall be verified that the hot-deck temperature controller setpoint tracks the schedule. The hot-deck temperature controller setpoint shall be set for the existing outside-air temperature as shown.

(6) The hot-deck temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of sensing element-to-controller readout shall be performed. The controller shall be placed in the local-setpoint mode, and set at the temperature setpoint as shown. The controller "MANUAL/AUTO" station shall be indexed to the

"AUTO" position, and the controller-tuning procedure performed.

(7) The cold-deck temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check of sensing element-to-controller readout shall be performed. The controller shall be placed in the local-setpoint mode, and set at the temperature setpoint as shown. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller-tuning procedure performed.

(8) An unoccupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night-thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the setting as shown.

(9) With the HVAC system running, a filter differential-pressure switch input signal shall be simulated at the device. It shall be verified that the filter pilot light turns on, and that contact output at the EMCS terminals is made. The differential-pressure switch shall be set at the setpoint as shown.

(10) With the HVAC system running, a freezestat trip input signal shall be simulated at the device. HVAC system shutdown shall be verified. It shall be verified that the low-temperature pilot light turns on, and contact output at EMCS terminals shall be verified. The freezestat shall be set at the setpoint as shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(11) With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and control-device actions and interlock functions, as described in paragraph CONTROL SEQUENCES OF OPERATION, shall be verified. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke-detector pilot light turns on, and contact output at the EMCS terminals is made. The detectors shall be reset. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(12) The setpoint of each zone thermostat shall be raised and it shall be verified that the dual-duct terminal box damper closes to the cold duct and opens to the hot duct. Each zone thermostat shall be calibrated and set at its setpoint as shown.

3.4.16 Bypass Multizone with Return Fan

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside-air and relief-air dampers shall be closed, the return-air damper open, and the cooling-coil valve closed.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air, return-air, mixed-air, and cold-deck-air temperatures shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:

(1) With the fans ready to start, the ventilation-delay-mode signal shall be applied, and it shall be verified that the ventilation-delay-mode pilot light turns on. The occupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns on and that supply fan [_____] and return fan [_____] start. It shall be verified that the outside-air and relief-air dampers are closed, the return-air damper is open, and the heating and cooling-coil valves are under control, by slightly changing the controller outputs. The ventilation-delay-mode signal shall be released, and it shall be verified that the ventilation-delay-mode pilot light turns off, and that the outside-air, return-air, and relief-air dampers come under control, by changing the controller output.

(2) The minimum-outside-air-mode signal shall be applied. It shall be verified that the outside-air damper opens to minimum position and that the economizer pilot light is off.

(3) The mixed-air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position. An economizer-mode input signal shall be simulated and it shall be verified that the economizer-mode pilot light turns on. The mixed-air temperature controller output shall be changed to slightly open the outside-air damper and the second point of the two-point calibration accuracy check of sensing element-to-controller readout for outside-air, return-air, and mixed-air temperatures shall be performed. The controller-tuning procedure shall be performed. The mixed-air temperature controller "MANUAL/AUTO" switch shall be indexed to the "AUTO" position. The mixed-air temperature controller shall be placed in the local setpoint mode and set at the temperature setpoint as shown.

(4) The cold-deck temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check of sensing element-to-controller readout shall be performed. The controller shall be placed in the local-setpoint mode, and set at the temperature setpoint as shown. The

controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller-tuning procedure performed.

(5) An unoccupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night-thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the setpoint as shown.

(6) With the HVAC system running, a filter differential-pressure switch input signal shall be simulated at the device. It shall be verified that the filter pilot light turns on, and that contact output at the EMCS terminals is made. The differential-pressure switch shall be set at the setpoint as shown.

(7) With the HVAC system running, a freezestat trip input signal shall be simulated at the device. HVAC system shutdown shall be observed. It shall be verified that the low-temperature pilot light turns on, and that contact output at the EMCS terminals is made. The freezestat shall be set at the setpoint as shown. The HVAC system shall be restarted by manual restart and it shall be verified that the pilot light turns off.

(8) With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and control-device actions and interlock functions as described in paragraph CONTROL SEQUENCES OF OPERATION shall be verified. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke-detector pilot light turns on, and contact output at the EMCS terminals is made. The detectors shall be reset. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(9) The setpoint of each zone thermostat shall be changed and correct operation of the zone damper and the heating coil valve shall be verified for each zone. Each zone thermostat shall be calibrated and set at its setpoint as shown.

3.4.17 Variable Air Volume, Without Return Fan

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside air and relief air dampers shall be closed, the return air damper open, and the supply fan inlet vanes and cooling coil valve shall be closed.

b. Step 2 - Calibration Accuracy Check with HVAC System in Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each controller display shall be read, and the thermometer and controller display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside air, return air, mixed air, and the cooling coil discharge air temperatures shall be checked. The minimum outside air flow shall be read, using a digital indicating velometer, and the velometer and controller display readings logged. The flow shall read zero.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control System Commissioning:

(1) With the fan ready to start, the ventilation delay mode signal shall be applied, and it shall be verified that the ventilation delay mode pilot light turns on. The occupied mode signal shall be applied, and it shall be verified that the occupied mode pilot light turns on and that supply fan [_____] starts. It shall be verified that the outside air and relief air dampers are closed, the return air damper is open, and the cooling coil valve and inlet vanes are under control, by slightly changing the controller output. The ventilation delay mode signal shall be released, and it shall be verified that the ventilation delay mode pilot light turns off and that the economizer outside air and relief air dampers remain closed, the return air damper remains open, and the minimum outside air damper comes under control of the minimum outside air flow controller, by changing the controller output.

(2) The 2-point calibration accuracy check of sensing element-to-controller readout for the minimum outside air flow measurement station shall be performed. VAV box dampers shall be forced to the full open position, exhaust fans turned off, the supply duct static pressure controller output manually adjusted to achieve the design duct static pressure, and manually adjust the minimum outside air flow controller output to achieve a flow which is approximately 25% less than the desired air flow. Under these conditions, the minimum outside air flow control loop shall be tuned. Stable operation of the minimum outside air flow control loop in response to a process disturbance shall be confirmed.

(3) With supply fan [_____] running, a high static pressure input signal shall be simulated at the device, by pressure input to the differential pressure switch sensing device. HVAC system shutdown shall be observed. It shall be verified that the high static pressure pilot light turns on, and that contact output at the EMCS terminals is made. The differential pressure switch shall be set at the setpoint shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the high static pressure pilot light turns off.

(4) The supply fan static pressure controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check for sensing

element-to-controller readout shall be performed. The controller shall be placed in the local setpoint mode. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller tuning procedure performed. The controller shall be set at the static pressure setpoint shown, and the mode constants logged.

(5) The mixed air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position. An economizer mode input signal shall be simulated and it shall be verified that the economizer mode pilot light turns on. The mixed air temperature controller output shall be changed to slightly open the economizer outside air damper and the second point of the two-point calibration accuracy check of sensing element-to-controller readout for outside air, return air, and mixed air temperatures shall be performed. The controller tuning procedure shall be performed. The mixed air temperature controller "MANUAL/AUTO" switch shall be indexed to the "AUTO" position. The mixed air temperature controller shall be placed in the local setpoint mode and set at the temperature setpoint shown.

(6) The cooling coil temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check of sensing element-to-controller readout shall be performed. The controller shall be placed in the local setpoint mode, and set at the temperature setpoint shown. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller tuning procedure performed.

(7) An unoccupied mode signal shall be applied, and it shall be verified that the occupied mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the setpoint shown.

(8) With the HVAC system running, a filter differential pressure switch input signal shall be simulated at the device. It shall be verified that the filter pilot light turns on, and that contact output at the EMCS terminals is made. The differential pressure switch shall be set at the setpoint shown.

(9) With the HVAC system running, a freezestat trip input signal shall be simulated at the device. HVAC system shutdown shall be observed. It shall be verified that the low temperature pilot light turns on, and that contact output at the EMCS terminals is made. The freezestat shall be set at the setpoint shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(10) With the HVAC system running, a smoke detector trip input signal shall be simulated at each detector, and control device actions and interlock functions, as described in paragraph CONTROL SEQUENCES OF OPERATION shall be verified. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke detector pilot light turns on, and contact output at the EMCS

terminals is made. The detectors shall be reset. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(11) Velocity setpoints for minimum and maximum flow and temperature setpoints for the heating/cooling dead band shall be set, for each VAV terminal unit. The actions of the controller, the operation of the damper, and the operation of heating shall be verified. It shall be verified that space temperature is maintained.

3.4.18   Variable Air Volume Control

Steps for installation of system with return fan shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside air and relief air dampers shall be closed, the return air damper open, and the inlet vanes and cooling coil valve shall be closed.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each controller display shall be read, and the thermometer and controller display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside air, return air, mixed air, and cooling coil discharge air temperatures shall be checked. The minimum outside air, supply air, and return air flows shall be read, using a digital indicating velometer, and the velometer and controller display readings logged. The flows shall read zero.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control System Commissioning:

(1) With the fans ready to start, the ventilation delay mode signal shall be applied, and it shall be verified that the ventilation delay mode pilot light turns on. The occupied mode signal shall be applied, and it shall be verified that the occupied mode pilot light turns on and that supply fan [_____] and return fan [_____] start. It shall be verified that the outside air and relief air dampers are closed, the return air damper is open, and the cooling coil valve and inlet vanes are under control, by slightly changing the controller output. The ventilation delay mode signal shall be released, and it shall be verified that the ventilation delay mode pilot light turns off and that the economizer outside air and relief air dampers remain closed, the return air damper remains open, and the minimum

outside air damper comes under control of the minimum outside air flow controller, by changing the controller output.

(2) The 2-point calibration accuracy check of sensing element-to-controller readout for the minimum outside air flow measurement station shall be performed. VAV box dampers shall be forced to the full open position, exhaust fans shall be truned off, the supply duct static pressure controller outputshall be manually adjusted to achieve the design duct static pressure, the return fan volume controller output shall be manually adjsuted to achieve the design differential flow difference between the supply and return duct flows, the minimum outside air flow controller output shall be manually adjusted to achieve a flow which is approximately 25% less than the desired air flow. Under these conditions, the minimum outside air flow control loop shall be tuned. Stable operation of the minimum outside air flow control loop in response to a process disturbance shall be confirmed.

(3) With supply fan [_____] running, a high static pressure input signal shall be simulated at the device, by pressure input to the differential pressure switch sensing device. HVAC system shutdown shall be observed. It shall be verified that the high static pilot light turns on, and that contact output at the EMCS terminals is made. The differential pressure switch shall be set at the setpoint shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the high static pressure pilot light turns off.

(4) The supply fan static pressure controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check for sensing element-to-controller readout shall be performed. The controller shall be placed in the local setpoint mode. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller tuning procedure performed. The controller shall be set at the static pressure setpoint, and the mode constants logged.

(5) Each VAV terminal unit controller's minimum flow and maximum flow setpoints shall be set at the same setting, to prevent the VAV box damper from modulating under space temperature control and to achieve a constant supply duct system pressure drop. The return fan inlet vane shall be placed under control, and the starter switch shall be turned to the "AUTO" position so that the fan starts. The "MANUAL/AUTO" station of the return fan air volume controller shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of sensing element-to-controller readout shall be performed. The controller shall be placed in the remote setpoint mode. Using the supply duct static pressure controller's "MANUAL" function, the supply fan inlet vane shall be operated to change the supply fan flow, and the controller ratio and bias settings shall be set to control at [_____] cfm at 4-ma input and [_____] cfm at 20-ma input. The supply fan flow shall be changed to verify that the return flow setpoint tracks the supply fan flow with the proper flow difference. A 12 ma signal shall be sent for tuning at setpoint midrange. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position and the controller tuning procedure shall be performed. A 4 ma, 12 ma and 20 ma signal shall be sent to the

remote setpoint input, and it shall be verified that the return fan goes from minimum delivery setpoint to midrange delivery setpoint, and then to maximum delivery setpoint. The supply duct static pressure controller shall be placed in "AUTO."

(6) The mixed air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position. An economizer mode input signal shall be simulated and it shall be verified that the economizer mode pilot light turns on. The mixed air temperature controller output shall be changed to slightly open the economizer outside air damper and the second point of the two-point calibration accuracy check of sensing element-to-controller readout for outside air, return air, and mixed air temperatures shall be performed. The controller tuning procedure shall be performed. The mixed air temperature controller "MANUAL/AUTO" switch shall be indexed to the "AUTO" position. The mixed air temperature controller shall be placed in the local setpoint mode and set at the temperature setpoint shown.

(7) The cooling coil temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check of sensing element-to-controller readout shall be performed. The controller shall be placed in the local setpoint mode, and set at the temperature setpoint shown. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller tuning procedure performed.

(8) An unoccupied mode signal shall be applied, and it shall be verified that the occupied mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the setpoint shown.

(9) With the HVAC system running, a filter differential pressure switch input signal shall be simulated at the device. It shall be verified that the filter pilot light turns on, and that contact output at the EMCS terminals is made. The differential pressure switch shall be set at the setpoint shown.

(10) With the HVAC system running, a freezestat trip input signal shall be simulated at the device. HVAC system shall shut down, and contact output at EMCS terminals shall be verified. It shall be verified that the low temperature pilot light turns on. The freezestat shall be set at the setpoint shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(11) With the HVAC system running, a smoke detector trip input signal shall be simulated at each detector and control device actions and interlock functions, as described in paragraph CONTROL SEQUENCES OF OPERATION shall be verified. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down, that the smoke detector pilot light turns on, and that contact output at the EMCS terminals is made. The detectors shall be reset. The HVAC system shall be restarted by manual restart, and it shall be verified

that the pilot light turns off.

(12) For each VAV terminal unit, velocity setpoints shall be set for minimum and maximum flow, and temperature setpoints shall be set for the heating/cooling dead band. The actions of the controller, the operation of the damper, and the operation of heating shall be verified. It shall be verified that space temperature is maintained.

3.4.19 Single-Zone with Hydronic Heating and Cooling Coils; No Return Fan

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be verified in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside-air and relief-air dampers shall be closed, the return-air damper shall be open, and the cooling-coil valve shall be closed.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air, return-air, and space temperatures shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:

(1) With the fan ready to start, the ventilation-delay-mode signal shall be applied, and it shall be verified that the ventilation-delay-mode pilot light turns on. The occupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns on and that supply fan [_____] starts. It shall be verified that the outside-air and relief-air dampers are closed, the return-air damper is open, and the heating-coil and cooling-coil valves are under control, by slightly changing the controller outputs. The ventilation-delay-mode signal shall be released, and it shall be verified that the ventilation-delay-mode pilot light turns off and that the outside-air, return-air, and relief-air dampers come under control by changing the controller output.

(2) The minimum-outside-air-mode signal shall be applied. It shall be verified that the outside-air damper opens to minimum position and the economizer pilot light is off.

(3) The space-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position. An economizer-mode input signal shall be simulated and it shall be verified that the economizer-mode pilot light turns on. The space-temperature controller output shall be changed and the second point of the two-point calibration accuracy check of sensing element-to-controller readout for outside-air, return-air, and space temperatures shall be performed. The controller shall be placed in the remote-setpoint mode. The setpoint low-end limit shall be set to 66 degrees F and the high-end limit shall be set to 72 degrees F. Proper operation of the temperature setpoint device at the space-temperature sensing element and transmitter location shall be verified. The space-temperature controller tuning procedure shall be performed. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position and the temperature setpoint device shall be set to the space temperature setpoint as shown. A change in space temperature shall be simulated and it shall be verified that the heating-coil valve and the cooling-coil valve operate in sequence as shown.

(4) An unoccupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night-thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the setpoint as shown.

(5) With the HVAC system running, a filter differential-pressure switch input signal shall be simulated at the device. It shall be verified that the filter pilot light turns on, and that contact output at the EMCS terminals is made. The differential-pressure switch shall be set at the setpoint as shown.

(6) With the HVAC system running, a freezestat trip input signal shall be simulated at the device. HVAC system shutdown shall be verified, the low-temperature pilot light shall turn on, and contact output at the EMCS terminals shall be verified. The freezestat shall be set at the setpoint as shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(7) With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and control-device actions and interlock functions, as described in paragraph CONTROL SEQUENCES OF OPERATION shall be verified. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke-detector pilot light turns on, and contact output at the EMCS terminals is made. The detectors shall be reset. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

3.4.20 Single-Zone with Dual-Temperature Coil; No Return Fan

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be verified in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside-air and relief-air dampers shall be closed, the return-air damper shall be open, and the cooling-coil valve shall be closed.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air, return-air, and space temperatures shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:

(1) With the fan ready to start, the ventilation-delay-mode signal shall be applied, and it shall be verified that the ventilation-delay-mode pilot light turns on. The occupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns on and that supply fan [_____] starts. It shall be verified that the outside-air and relief-air dampers are closed, the return-air damper is open, and the dual-temperature coil control valve is under control, by slightly changing the controller outputs. The ventilation-delay-mode signal shall be released, and it shall be verified that the ventilation-delay-mode pilot light turns off and that the outside-air, return-air, and relief-air dampers come under control by changing the controller output.

(2) The minimum-outside-air-mode signal shall be applied. It shall be verified that the outside-air damper opens to minimum position and the economizer pilot light is off.

(3) The heating-season and cooling-season space-temperature controllers "MANUAL/AUTO" stations shall be indexed to the "MANUAL" position. An economizer-mode input signal shall be simulated and it shall be verified that the economizer-mode pilot light turns on. One space-temperature controller output shall be changed and the second point of the two-point calibration accuracy check of sensing element-to-controller readout for outside-air, return-air, and space temperatures (as indicated at both space-temperature controllers) shall be performed. The controllers shall be placed in the remote-setpoint mode. The setpoint low-end limit shall be set to 66 degrees F and the high-end limit shall be set to 72 degrees F.Proper operation of the temperature setpoint device at the space-temperature sensing element and transmitter location shall be verified. The tuning

procedure shall be performed for the heating-season and cooling-season space-temperature controllers. The controller "MANUAL/AUTO" station for the heating-season and cooling-season space-temperature controllers shall be indexed to the "AUTO" position and the temperature setpoint device shall be set to the space temperature setpoint as shown.

(4) Dual-temperature hydronic changeover operation of aquastat shall be simulated. Control system selection of opposite season space-temperature controller shall be verified.

(5) An unoccupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night-thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the setpoint as shown.

(6) With the HVAC system running, a filter differential-pressure switch input signal shall be simulated at the device. It shall be verified that the filter pilot light turns on, and that contact output at the EMCS terminals is made. The differential-pressure switch shall be set at the setpoint as shown.

(7) With the HVAC system running, a freezestat trip input signal shall be simulated, at the device. HVAC system shutdown shall be verified. The low-temperature pilot light shall turn on; and contact output at EMCS terminals shall be verified. The freezestat shall be set at the setpoint as shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(8) With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and control-device actions and interlock functions, as described in paragraph CONTROL SEQUENCES OF OPERATION shall be verified. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke-detector pilot light turns on, and contact output at the EMCS terminals is made. The detectors shall be reset. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

3.4.21 Single-Zone with Humidification; No Return Fan

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be verified in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside-air damper, humidifier valve and cooling-coil valve shall be closed.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air and space temperatures shall be checked. Using a motor-driven psychrometer, the wet-bulb and dry-bulb temperatures of the humidifier discharge air and of the air in the space, shall be checked; the controller display shall be read, and the psychrometer and controller-display readings shall be logged.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma [or 3 psig] to 20 ma [or 15 psig], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:

(1) With the fan ready to start, the ventilation-delay-mode signal shall be applied, and it shall be verified that the ventilation-delay-mode pilot light turns on. The occupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns on and that supply fan [_____] starts. It shall be verified that the outside-air damper is closed, and the heating-coil, cooling-coil, and humidifier valves are under control, by slightly changing the controller outputs. The ventilation-delay-mode signal shall be released, and it shall be verified that the ventilation-delay-mode pilot light turns off and that the outside air damper opens.

(2) The outside-air preheat-coil temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check of sensing element-to-controller readout shall be performed. The controller shall be placed in the local-setpoint mode, and set at the temperature setpoint as shown. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller-tuning procedure performed.

(3) The space-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position. An economizer-mode input signal shall be simulated and it shall be verified that the economizer-mode pilot light turns on. The space-temperature controller output shall be changed and the second point of the two-point calibration accuracy check of sensing element-to-controller readout for outside-air, return-air, and space temperatures shall be performed. The controller shall be placed in the remote-setpoint mode. The setpoint low-end limit shall be set to 66 degrees F and the high-end limit shall be set to 72 degrees F. Proper operation of the temperature setpoint device at the space-temperature sensing element and transmitter location shall be verified. The space-temperature controller tuning procedure shall be performed. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position and the temperature setpoint device shall be set to the space temperature setpoint as shown.

(4) The relative-humidity controller and high-limit-humidity controller "MANUAL/AUTO" stations shall be indexed to the "MANUAL" position. All controller outputs shall be set to minimum. The outputs of the relative-humidity controller and the space-temperature controller shall be changed to verify that the signal selector for the cooling valve selects the proper signal. The outputs of the relative-humidity controller and the high-limit relative-humidity controller shall be changed to verify that the signal selector for the humidifier valve selects the proper signal.

(5) The relative-humidity controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check for sensing element-to-controller readout shall be performed. An identical calibration accuracy check and tuning procedure for the high-limit relative-humidity controller shall be performed. The controller shall be placed in the local setpoint mode, and the controller-tuning procedure shall be performed. The controller shall be set at the setpoint as shown. The high-limit relative-humidity controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller-tuning procedure shall be performed. The controller shall be placed in the local setpoint mode. The duct high-limit-humidity controller shall be set at the setpoint as shown. A high-limit transmitter input signal equal to the high-limit value shall be simulated. It shall be verified that the humidifier valve closes. The signal shall be decreased to a value of 5 percent relative humidity below the high-limit value. It shall be verified that the primary controller resumes control.

(6) The hydronic-heating temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position. The controller output shall be changed to open the converter valve slightly. The two-point calibration accuracy check for sensing element-to-controller readout shall be performed. The controller shall be placed in the remote-setpoint mode. The remote setpoint shall be set for plus 5 degree F setpoint at 4 ma input. A 12 ma signal shall be sent to the remote setpoint for calibration at midrange. The temperature-controller "MANUAL/AUTO" switch shall be indexed to the "AUTO" position, the controller-tuning procedure shall be performed, and the mode-constants logged. Signals of 8 ma and 16 ma shall be sent to the remote setpoint, and it shall be verified that the controller setpoint changes to the appropriate values. The controller shall be set in the local-setpoint mode and set at the temperature setpoint as shown.

(7) An unoccupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night-thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the setpoint as shown.

(8) With the HVAC system running, a filter differential-pressure switch input signal shall be simulated at the device. It shall be verified that the filter pilot light turns on, and that contact output at the EMCS terminals is made. The differential-pressure

switch shall be set at the setpoint as shown.

(9) With the HVAC system running, a freezestat trip input signal shall be simulated at the device. HVAC system shutdown shall be verified; the low-temperature pilot light shall turn on, and contact output at the EMCS terminals shall be verified. The freezestat shall be set at the setpoint as shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(10) With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and control-device actions and interlock functions, as described in paragraph CONTROL SEQUENCES OF OPERATION shall be verified. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke-detector pilot light turns on, and contact output at the EMCS terminals is made. The detectors shall be reset. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

3.4.22 Single-Zone with Hydronic-Heating, Direct-Expansion Cooling

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be verified in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside-air and relief-air dampers shall be closed, the return-air damper shall be open, and all stages of cooling shall be off.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air, return-air, and space temperatures shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma to 20 ma, and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other. The signal levels that move the controlled device to its extreme positions shall be logged. The operating points of the sequence shall be set for each stage of cooling and the proper operation of each stage shall be verified.

d. Step 4 - Control-System Commissioning:

(1) With the fan ready to start, the ventilation-delay-mode signal shall be applied, and it shall be verified that the ventilation-delay-mode pilot light turns on. The occupied-mode

signal shall be applied, and it shall be verified that the occupied-mode pilot light turns on and that supply fan [_____] starts. It shall be verified that the outside-air and relief-air dampers are closed, the return-air damper is open, and the heating-coil and stages of cooling are under control, by slightly changing the controller output. The ventilation-delay-mode signal shall be released, and it shall be verified that the ventilation-delay-mode pilot light turns off and that the outside-air, return-air, and relief-air dampers come under control by changing the controller output.

(2) The minimum-outside-air-mode signal shall be applied. It shall be verified that the outside-air damper opens to minimum position and the economizer pilot light is off.

(3) The space-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check for sensing element-to-controller readout performed. The controller shall be placed in the remote-setpoint mode. The setpoint low-end limit shall be set to 66 degrees F and the high-end limit shall be set to 72 degrees F. Proper operation of the temperature setpoint device at the space-temperature sensing element and transmitter location shall be verified. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller-tuning procedure shall be performed. The temperature setpoint device shall be set to the space temperature setpoint as shown. A change in space temperature shall be simulated and it shall be verified that the heating-coil valve and the stages of D/X cooling operate in sequence as shown.

(4) An unoccupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night-thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the setpoint as shown.

(5) With the HVAC system running, a filter differential-pressure switch input signal shall be simulated at the device. It shall be verified that the filter pilot light turns on, and that contact output at the EMCS terminals is made. The differential-pressure switch shall be set at the setpoint as shown.

(6) With the HVAC system running, a freezestat trip input signal shall be simulated at the device. HVAC system shutdown shall be verified; the low-temperature pilot light shall turn on, and contact output at the EMCS terminals shall be verified. The freezestat shall be set at the setpoint as shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(7) With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and control-device actions and interlock functions as described in paragraph CONTROL SEQUENCES OF OPERATION shall be verified. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and that the

smoke-detector pilot light turns on, and contact output at the EMCS terminals is made. The detectors shall be reset. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

3.5 BALANCING, COMMISSIONING, AND TESTING

3.5.1 Coordination with HVAC System Balancing

Commissioning of the control system, except for tuning of controllers, shall be performed prior to or simultaneous with HVAC system balancing. The Contractor shall tune the HVAC control system after all air-system and hydronic-system balancing has been completed, minimum damper positions set and a report has been issued.

3.5.2 Control System Calibration, Adjustments, and Commissioning

Control system commissioning shall be performed for each HVAC system, using test plans and procedures previously approved by the Government. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform commissioning and testing of the HVAC control system. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Wiring shall be tested for continuity and for ground, open, and short circuits. Tubing systems shall be tested for leaks. Mechanical control devices shall be adjusted to operate as specified. HVAC control panels shall be pretested off-site as a functioning assembly ready for field connections, calibration, adjustment, and commissioning of the operational HVAC control system. Written notification of any planned commissioning or testing of the HVAC Control systems shall be given to the Government at least 14 calendar days in advance.

3.5.3 Performance Verification Test

The Contractor shall demonstrate compliance of the HVAC control system with the contract documents. Using test plans and procedures previously approved by the Government, the Contractor shall demonstrate all physical and functional requirements of the project. The performance verification test shall show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. The performance verification test shall not be started until after receipt by the Contractor of written permission by the Government, based on Government approval of the commissioning report and completion of balancing. The tests shall not be conducted during scheduled seasonal off-periods of base heating and cooling systems.

3.5.4 Posted and Panel Instructions

Posted and panel instructions, showing the final installed conditions, shall be provided for each system. The posted instructions shall consist of half-size laminated drawings and shall include the control system schematic, equipment schedule, ladder diagram, sequence of operation, panel arrangement drawings, wiring diagram, and valve and damper schedules. The posted instructions shall be permanently affixed, by mechanical means, to a wall near the control panel. Panel instructions shall consist of laminated letter-size sheets and shall include a routine maintenance checklist and controller configuration check sheets with final configuration record for each controller. Panel instructions and one copy of the operation and maintenance manuals, previously described herein, shall be placed inside each control panel.

3.6 TRAINING

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NOTE: Training requirements should be coordinated with the user. Extent of training should be based on the number of systems being installed and the needs of the operation and maintenance staff. If training has been provided through previous projects, the training requirements may be minimal.

****

3.6.1 Training-Course Requirements

A training course shall be conducted for [_____] operating staff members designated by the Contracting Officer. The training period, for a total of [32] [_____] hours of normal working time, shall be conducted within 30 days after successful completion of the performance verification test. The training course shall be conducted at the project site. Audiovisual equipment and [_____] sets of all other training materials and supplies shall be provided. A training day is defined as 8 hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

3.6.2 Training-Course Content

For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are familiar with HVAC systems. The training course shall cover all of the material contained in the operating and maintenance instructions, the layout and location of each HVAC control panel, the layout of one of each type of unitary equipment and the locations of each, the location of each system-control device external to the panels, the location of the compressed-air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the calibration, adjustment and commissioning report shall be presented as benchmarks of HVAC control-system performance by which to measure operation and maintenance effectiveness.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-15990 (August 1997)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**
Superseding
CEGS-15990 (October 1989)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 2 (March 1999)

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SECTION 15990

TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS

08/97

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SECTION 15990

TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS
08/97

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NOTE: This guide specification covers the requirements for the testing, adjusting, and balancing (TAB) of all heating, ventilating and air conditioning systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

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PART 1 GENERAL

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NOTE: This specification should be used on all projects which include new HVAC systems or modifications to existing HVAC systems.

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1.1 REFERENCES

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NOTE: Issue (date) of references included in the project specifications need be not be more current than provided by the latest change (Notice) to the

guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1	(1989) National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB Procedural Stds	(1991) Procedural Standards for Testing Adjusting Balancing of Environmental Systems

1.2 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having a "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

TAB Related HVAC Submittals; FIO.

A list of the TAB Related HVAC Submittals, no later than [7] [_____] days after the approval of the TAB Specialist.

SD-04 Drawings

TAB Schematic Drawings and Report Forms; GA.

[Three] [_____] copies of the TAB Schematic Drawings and Report Forms, no later than [21] [_____] days prior to the start of TAB field measurements.

SD-06 Instructions

TAB Procedures; GA.

Proposed procedures for TAB, submitted with the TAB Schematic Drawings and

Report Forms.

SD-07 Schedules

Systems Readiness Check; FIO.

Proposed date and time to begin the Systems Readiness Check, no later than [7] [_____] days prior to the start of the Systems Readiness Check.

TAB Execution; GA.

Proposed date and time to begin field measurements, making adjustments, etc., for the TAB Report, submitted with the Systems Readiness Check Report.

TAB Verification; GA.

Proposed date and time to begin the TAB Verification, submitted with the TAB Report.

SD-08 Statements

TAB Firm; GA.

Certification of the proposed TAB Firm's qualifications by either AABC or NEBB to perform the duties specified herein and in other related Sections, no later than [21] [_____] days after the Notice to Proceed. The documentation shall include the date that the Certification was initially granted and the date that the current Certification expires. Any lapses in Certification of the proposed TAB Firm or disciplinary action taken by AABC or NEBB against the proposed TAB Firm shall be described in detail.

TAB Specialist; GA.

Certification of the proposed TAB Specialist's qualifications by either AABC or NEBB to perform the duties specified herein and in other related Sections, no later than [21] [_____] days after the Notice to Proceed. The documentation shall include the date that the Certification was initially granted and the date that the current Certification expires. Any lapses in Certification of the proposed TAB Specialist or disciplinary action taken by AABC or NEBB against the proposed TAB Specialist shall be described in detail.

Instrument Calibration; FIO.

List of each instrument to be used during TAB, stating calibration requirements required or recommended by both the TAB Standard and the instrument manufacturer and the actual calibration history of the instrument, submitted with the TAB Procedures. The calibration history shall include dates calibrated, the qualifications of the calibration laboratory, and the calibration procedures used.

SD-09 Reports

Design Review Report; GA.

A copy of the Design Review Report, no later than [14] [_____] days after approval of the TAB Firm and the TAB Specialist.

Systems Readiness Check Report; GA.

A copy of completed checklists for each system, each signed by the TAB Specialist, at least [7] [_____] days prior to the start of TAB Execution. All items in the Systems Readiness Check Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

TAB Report; GA.

[Three] [_____] copies of the completed TAB Reports, no later that [7] [_____] days after the execution of TAB. All items in the TAB Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

TAB Verification Report; GA.

[Three] [_____] copies of the completed TAB Verification Report, no later that [7] [_____] days after the execution of TAB Verification. All items in the TAB Verification Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

SD-13 Certificates

Ductwork Leak Testing; FIO.

A written statement signed by the TAB Specialist certifying that the TAB Specialist witnessed the Ductwork Leak Testing, it was successfully completed, and that there are no known deficiencies related to the ductwork installation that will prevent TAB from producing satisfactory results.

1.3 SIMILAR TERMS

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results. The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC or NEBB requirements where differences exist.

SIMILAR TERMS

Contract Term	AABC Term	NEBB Term
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
TAB Specialist	TAB Engineer	TAB Supervisor
Systems Readiness Check	Construction Phase Inspection	Field Readiness Check & Preliminary Field Procedures.

1.4 TAB STANDARD

TAB shall be performed in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1or NEBB Procedural Stds, unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard shall be considered mandatory. The provisions of the TAB Standard, including checklists, report forms, etc., shall, as nearly as practical, be used to satisfy the Contract requirements. The TAB Standard shall be used for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, the manufacturer's recommendations shall be adhered to. All quality assurance provisions of the TAB Standard such as performance guarantees shall be part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures shall be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC or NEBB), the requirements and recommendations contained in these procedures and requirements shall be considered mandatory.

1.5 QUALIFICATIONS

1.5.1 TAB Firm

The TAB Firm shall be either a member of AABC or certified by the NEBB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including [TAB of environmental systems] [the performance of clean rooms and clean air devices] [building systems commissioning] [and] [the measuring of sound and vibration in environmental systems]. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor shall immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm shall be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor. These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm shall be a subcontractor of the prime Contractor, and shall report to and be paid by the prime Contractor.

1.5.2 TAB Specialist

The TAB Specialist shall be either a member of AABC or an experienced technician of the Firm certified by the NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the Contractor shall immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

1.6 TAB SPECIALIST RESPONSIBILITIES

All TAB work specified herein and in related sections shall be performed under the direct guidance of the TAB Specialist. [The TAB Specialist shall participate in the commissioning process specified in Section 15995 COMMISSIONING OF HVAC SYSTEMS.]

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

****

NOTE: The planning and programming of either Title II services or in house support will be required where the participation of a design team member is required for TAB during construction.

****

3.1 DESIGN REVIEW

The TAB Specialist shall review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

3.2 TAB RELATED HVAC SUBMITTALS

The TAB Specialist shall prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the TAB Specialist when submitted to the Government. The TAB Specialist shall also ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

3.3 TAB SCHEMATIC DRAWINGS AND REPORT FORMS

A schematic drawing showing each system component, including balancing devices, shall be provided for each system. Each drawing shall be accompanied by a copy of all report forms required by the TAB Standard used for that system. Where applicable, the acceptable range of operation or appropriate setting for each component shall be included on the forms or as an attachment to the forms. The schematic drawings shall identify all testing points and cross reference these points to the report forms and procedures.

3.4 DUCTWORK LEAK TESTING

The TAB Specialist shall witness the Ductwork Leak Testing specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM and approve the results as specified in Paragraph TAB RELATED HVAC SUBMITTALS.

3.5 TESTING, ADJUSTING, AND BALANCING

3.5.1 TAB Procedures

****

NOTE: Where specific TAB Procedures are not covered in the TAB Standard and the designer feels that the level of complexity of the HVAC system or the critical nature of the area served warrants, procedures should be developed and added to this paragraph. During the TAB of kitchen exhaust hoods, incorrect building air flows may affect the performance of fans. Opening of kitchen entrance doors may produce correct exhaust hood air flows while closed doors yield deficient readings. TAB of kitchen exhaust hoods should be performed after make-up air flows are balanced and with the kitchen exhaust hoods should be performed after make-up air flows are balanced and with the kitchen entrance doors both opened and closed.

****

Step by step procedures for each measurement required during TAB Execution shall be provided. The procedures shall be oriented such that there is a separate section for each system. The procedures shall include measures to ensure that each system performs as specified in all operating modes, interactions with other components (such as exhaust fans, kitchen hoods, fume hoods, relief vents, etc.) and systems, and with all seasonal operating differences, diversity, simulated loads, and pressure relationships required.

3.5.2 Systems Readiness Check

The TAB Specialist shall inspect each system to ensure that it is complete, including installation and operation of controls, and that all aspects of the facility that have any bearing on the HVAC systems, including installation of ceilings, walls, windows, doors, and partitions, are complete to the extent that TAB results will not be affected by any detail or touch-up work remaining. The TAB Specialist shall also verify that all items such as ductwork and piping ports, terminals, connections, etc., necessary to perform TAB shall be complete during the Systems Readiness Check.

3.5.3 Preparation of TAB Report

Preparation of the TAB Report shall begin only when the Systems Readiness Report has been approved. The Report shall be oriented so that there is a separate section for each system. The Report shall include a copy of the appropriate approved Schematic Drawings and TAB Related Submittals, such as pump curves, fan curves, etc., along with the completed report forms for each system. The operating points measured during successful TAB Execution and the theoretical operating points listed in the approved submittals shall be marked on the performance curves and tables. Where possible, adjustments shall be made using an "industry standard" technique which would result in the greatest energy savings, such as adjusting the speed of a fan instead of throttling the flow. Any deficiencies outside of the realm of normal adjustments and balancing during TAB Execution shall be noted along with a description of corrective action performed to bring the measurement into the specified range. If, for any reason, the TAB Specialist determines during TAB Execution that any Contract requirement cannot be met, the TAB Specialist shall immediately provide a written description of the deficiency and the corresponding proposed corrective action necessary for proper system operation to the Contracting Officer.

3.5.4 TAB Verification

****
NOTE: Where, on projects with a small number of TAB measurements, it is impractical to specify a percentage of measurements to be verified, this paragraph should be modified to specify the number of measurements.
****

The TAB Specialist shall recheck ten percent of the measurements listed in the Tab Report and prepare a TAB Verification Report. The measurements selected for verification and the individuals that witness the verification will be selected by the Contracting Officer's Representative (COR). The measurements will be recorded in the same manner as required for the TAB Report. All measurements that fall outside the acceptable operating range specified shall be accompanied by an explanation as to why the measurement does not correlate with that listed in the TAB Report and a description of corrective action performed to bring the measurement into the specified range. The TAB Specialist shall update the original TAB report to reflect any changes or differences noted in the TAB verification report and submit the updated TAB report. If over 20 [_____] percent of the measurements selected by the COR for verification fall outside of the acceptable operating range specified, the COR will select an additional ten [_____] percent for verification. If over 20 [_____] percent of the total tested (including both test groups) fall outside of the acceptable range, the TAB Report shall be considered invalid and all contract TAB work shall be repeated beginning with the Systems Readiness Check.

3.5.5 Marking of Setting

Following approval of TAB Verification Report, the setting of all HVAC adjustment devices including valves, splitters, and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time.

3.5.6 Identification of Test Ports

The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leakage or to maintain integrity of vapor barrier.

-- End of Section --

****

DEPARTMENT OF THE ARMY **CEGS-15995 (January 1993)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 3 (May 1999)
Includes note relocation Special change (August 1995)
Includes Text Adjustment Change (Section Reference) (June 1997)

Latest change indicated by CHG tags

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SECTION 15995

COMMISSIONING OF HVAC SYSTEMS

01/93

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Latest change indicated by CHG tags

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SECTION 15995

COMMISSIONING OF HVAC SYSTEMS
01/93

****
NOTE: This guide specification covers the requirements for commissioning of HVAC systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

****
NOTE: Use of this specification is mandatory for Air Force projects. For all other projects, the use of this specification is strongly suggested. This is especially true for large or complex projects or when the HVAC system is critical. Districts should encourage our customers to take advantage of this service. A properly functioning HVAC system assures a comfortable, healthy and productive environment for the user. For maximum benefit the using agency and the designer must actively participate in the commissioning process.
****

1.1 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals with "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Commissioning Team; FIO.

List of team members who will represent the Contractor in the pre-commissioning checks and functional performance testing, at least 2 weeks prior to the start of pre-commissioning checks. Proposed revision to the list, prior to the start of the impacted work.

SD-06 Instructions

Test Procedures; [_____].

Detailed procedures for pre-commissioning checks and functional performance tests, at least 4 weeks prior to the start of pre-commissioning checks.

SD-07 Schedules

Test Schedule; GA.

Schedule for pre-commissioning checks and functional performance tests, at least 2 weeks prior to the start of pre-commissioning checks.

SD-09 Reports

Test Reports; GA.

Completed pre-commissioning checklists and functional performance test checklists organized by system and by subsystem and submitted as one package. The results of failed tests shall be included along with a description of the corrective action taken.

1.2 SEQUENCING AND SCHEDULING

****

NOTE: Provide seismic requirements, if a Government designer (either Corps office of A/E) is the

Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not included. Sections 13080 and 15070, properly edited, must be included in the contract documents.
****

The work described in this Section shall begin only after all work required in related Sections, including Section 15950 HEATING, VENTILATING, AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS and Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS, has been successfully completed, and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved.Seismic details shall be in accordance with Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT [as indicated]

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 COMMISSIONING TEAM AND CHECKLISTS

****
NOTE: The "design Agent's Representative" will be a member of the HVAC design team, i.e. from the AE or from Engineering Division. Where possible the "Design Agent's Representative" should be included as a member of the commissioning team for the pre-commissioning checklists. The Design Agent's Representative will participate in functional performance tests. The planning and programming of either Title II services or in house support will be required for the participation of the Design Agent's Representative.

The checklists provided are to be used as guides for the preparation of project checklists. The appropriate checklist should be included in the project specification for each HVAC equipment component. The designer will add additional checklists for equipment or systems not included in this guide specification or modify the checklists where necessary for specific project requirements. If, for example, a system needs to be tested with certain internal load, each appropriate checklist should be modified to include this requirement along with specifics on how load should be generated.
****

The Contractor shall designate team members to participate in the pre-commissioning checks and the functional performance testing specified herein. In addition, the Government will be represented by a representative of the Contracting Officer, the Design Agent's Representative, and the Using Agency. The team members shall be as follows:

Designation Function

Q	Contractor's Chief Quality Control Representative
M	Contractor's Mechanical Representative
E	Contractor's Electrical Representative
T	Contractor's Testing, Adjusting, and Balancing Representative
C	Contractor's Controls Representative
D	Design Agent's Representative
O	Contracting Officer's Representative
U	Using Agency's Representative

Each checklist shown in appendices A and B shall be completed by the commissioning team. Acceptance by each commissioning team member of each pre-commissioning checklist item shall be indicated by initials and date unless an "X" is shown indicating that participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test checklist shall be indicated by signature and date.

3.2 TESTS

****

NOTE: The use of the third and fourth sentences is optional for Army projects and mandatory for all Air Force projects.

****

The pre-commissioning checks and functional performance tests shall be performed in a manner which essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, methods shall be established which will provide the information required. Testing and verification required by this section shall be performed during the Commissioning phase. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section. The Contractor shall provide all materials, services, and labor required to perform the pre-commissioning checks and functional performance tests. A pre-commissioning check or functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test. The Contractor shall reimburse the Government for all costs associated with effort lost due to tests that are aborted. These costs shall include salary, travel costs and per diem (where applicable) for Government commissioning team members.

3.2.1 Pre-Commissioning Checks

Pre-commissioning checks shall be performed for the items indicated on the checklists in Appendix A. Deficiencies discovered during these checks shall be corrected and retested in accordance with the applicable contract requirements.

3.2.2 Functional Performance Tests

Functional performance tests shall be performed for the items indicated on the checklists in Appendix B. Functional performance tests shall begin only after all pre-commissioning checks have been successfully completed.

Tests shall prove all modes of the sequences of operation, and shall verify all other relevant contract requirements. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. The checklist shall then be repeated until it has been completed with no errors.

APPENDIX A

PRE-COMMISSIONING CHECKLISTS

Pre-commissioning checklist - Piping

For [_____] Piping System

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Piping complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
c. Piping flushed and cleaned.	___	___	X	___	X	___	___	___
d. Strainers cleaned.	___	___	X	___	X	___	___	___
e. Valves installed as required.	___	___	X	___	X	___	___	___
f. Piping insulated as required.	___	___	X	___	X	___	___	___
g. Thermometers and gauges installed as required.	___	___	X	___	X	___	___	___
h. Verify operation of valves.	___	___	X	___	___	___	___	___
i. Air vents installed as specified.	___	___	X	X	X	___	___	___
j. Flexible connectors installed as specified	___	___	X	X	X	___	___	___
k. Verify that piping has been labeled and valves identified as specified.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Hydrostatic test complete.	___	___	X	___	X	___	___	___
b. TAB operation complete.	___	___	X	___	___	___	___	___

Pre-commissioning Checklist - Ductwork

For Air Handler: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Ductwork complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
c. Ductwork leak test complete.	___	___	X	___	X	___	___	___

NOTE: The first bracketed item d will be used for Army projects, the second for Air Force projects.

Checklist Item	Q	M	E	T	C	D	O	U
[d. Fire dampers, smoke dampers, and access doors installed as required.	___	___	X	___	X	___	___	___]
[d. Fire dampers, smoke dampers, and access doors installed as required with installation of each verified by the specified team members initialing each location on a copy of the as-built drawings.	___	___	X	___	X	___	___	___]
e. Ductwork insulated as required.	___	___	X	___	X	___	___	___
f. Thermometers and gauges installed as required.	___	___	___	___	___	___	___	___
g. Verify open/closed status of dampers.	___	___	X	___	X	___	___	___
h. Verify smoke dampers operation.	___	___	X	___	___	___	___	___
i. Flexible connectors installed as specified	__	___	X	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB operation complete.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Multizone Air Handling Unit

For Air Handling Unit: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Vibration isolation devices installed [and freed to float with adequate movement and seismic restraint] as specified.	___	___	X	X	X	___	___	___
b. Inspection and access doors are operable and sealed.	___	___	X	___	X	___	___	___
c. Casing undamaged.	___	___	X	X	X	___	___	___
d. Insulation undamaged.	___	___	X	X	X	___	___	___
e. Condensate drainage is unobstructed. (Visually verify pan drains completely by pouring a cup of water into drain pan.)	___	___	X	X	X	___	___	___
f. Fan belt adjusted.	___	___	X	___	X	___	___	___
g. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
[e. Power available to electric heating coil.	___	___	___	X	___	___	___	___]
Coils								
[a. Chilled water piping properly connected.	___	___	X	X	X	___	___	___]
[a. Refrigerant piping properly connected.	___	___	X	X	X	___	___	___]
[b. Chilled water piping pressure tested.	___	___	X	X	X	___	___	___]
[b. Refrigerant piping pressure tested.	___	___	X	X	X	___	___	___]
[c. Hot water piping properly connected.	___	___	X	X	X	___	___	___]
[c. Steam and condensate piping properly connected.	___	___	X	X	X	___	___	___]
[d. Hot water piping pressure tested.	___	___	X	X	X	___	___	___]

Pre-commissioning Checklist - Multizone Air Handling Unit

For Air Handling Unit: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
[d. Steam and condensate piping pressure tested.	___	___	X	X	X	___	___	___]
e. Air vents installed on water coils [with shutoff valves] as specified.	___	___	X	X	X	___	___	___
f. Any damage to coil fins has been repaired	__	___	X	___	X	___	___	___
Controls								
a. Control valves/actuators properly installed.	___	___	X	___	___	___	___	___
b. Control valves/actuators operable.	___	___	X	___	___	___	___	___
c. O.A. dampers/actuators properly installed.	__	___	X	___	___	___	___	___
d. O.A. dampers/actuators operable.	___	___	X	___	___	___	___	___
e. Zone dampers/actuators properly installed.	__	___	X	___	___	___	___	___
f. Zone dampers/actuators operable.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Construction filters removed and replaced.	__	___	X	___	X	___	___	___
b. TAB report submitted.	___	___	X	___	X	___	___	___
c. TAB results within +10%/-0% of cfm shown on drawings								
d. TAB results for outside air intake within +10%/-0% of CFM shown on drawings.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Vibration isolation devices installed.	___	___	X	X	X	___	___	___
b. Inspection and access doors are operable and sealed.	___	___	X	___	X	___	___	___
c. Casing undamaged.	___	___	X	X	X	___	___	___
d. Insulation undamaged.	___	___	X	X	X	___	___	___
e. Condensate drainage is unobstructed. (Visually verify drainage by pouring a cup of water into drain pan.)	___	___	X	X	X	___	___	___
f. Fan belt adjusted.	___	___	X	___	X	___	___	___
g. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	X	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
[e. Power available to electric heating coil.	___	___	___	X	X	___	___	___]
Coils								
[a. Chilled water piping properly connected.	___	___	X	X	X	___	___	___]
[a. Refrigerant piping properly connected.	___	___	X	X	X	___	___	___]
[b. Chilled water piping pressure tested.	___	___	X	X	X	___	___	___]
[b. Refrigerant piping pressure tested.	___	___	X	X	X	___	___	___]
[c. Hot water piping properly connected.	___	___	X	X	X	___	___	___]
[c. Steam and condensate piping properly connected.	___	___	X	X	X	___	___	___]
[d. Hot water piping pressure tested.	___	___	X	X	X	___	___	___]
[d. Steam and condensate piping pressure tested.	___	___	X	X	X	___	___	___]

Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
[e. Air vents installed on water coils [with shutoff valves] as specified.			X	X	X			]
f. Any damage to coil fins has been repaired.			X		X			
Controls								
a. Control valves/actuators properly installed.			X					
b. Control valves/actuators operable.			X					
c. Dampers/actuators properly installed.			X					
d. Dampers/actuators operable.			X					
e. Verify proper location, installation and calibration of duct static pressure sensor.			X					
f. Fan air volume controller operable.			X					
g. Air handler controls system operational.			X					
Testing, Adjusting, and Balancing (TAB)								
a. Construction filters removed and replaced.			X					
b. TAB report submitted.			X		X			
c. TAB results within +10%/-0% of cfm shown on drawings								
d. TAB results for outside air intake within +10%/-0% of both the minimum and maximum cfms shown on drawings.			X		X			

Pre-commissioning Checklist - VAV Terminal

For VAV Terminal: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. VAV terminal in place.			X	X	X			
b. VAV terminal ducted.			X	X	X			
c. VAV terminal connected to controls.			X	X				
[d. Reheat coil connected to hot water pipe.			X		X			]
[e. Electric reheat coil connected to local disconnect.					X			]
f. Manufacturer's required maintenance clearance provided.			X	X	X			
Controls								
a. Cooling only VAV terminal controls set.			X	X				
b. Cooling only VAV controls verified.			X	X				
c. Reheat VAV terminal controls set.			X	X				
d. Reheat terminal/coil controls verified.			X	X				
Testing, Adjusting, and Balancing (TAB)								
a. Verify terminal maximum air flow set.			X					
b. Verify terminal minimum air flow set.			X					
c. TAB operation complete.			X		X			

Pre-commissioning Checklist - DX Air Cooled Condensing Unit

For Condensing Unit: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation	___	___	X	X	X	___	___	___
b. Refrigerant pipe leak tested.	___	___	X	X	X	___	___	___
c. Refrigerant pipe evacuated and charged in accordance with manufacturer's instructions.	___	___	X	X	X	___	___	___
d. Check condenser fans for proper rotation.	___	___	X	___	X	___	___	___
e. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
f. Manufacturer's required maintenance/ operational clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	X	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls	___	___	___	X	___	___	___	___
Controls								
a. Unit safety/protection devices tested.	___	___	X	X	___	___	___	___
b. Control system and interlocks installed.	___	___	X	X	___	___	___	___
c. Control system and interlocks operational.	___	___	X	X	___	___	___	___

Pre-commissioning Checklist - Pumps

For Pump: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Pumps grouted in place.	___	___	X	X	X	___	___	___
b. Pump vibration isolation devices functional.	___	___	X	X	X	___	___	___
c. Pump/motor coupling alignment verified.	___	___	X	X	X	___	___	___
d. Piping system installed.	___	___	X	X	X	___	___	___
e. Piping system pressure tested.	___	___	X	X	X	___	___	___
f. Pump not leaking.	___	___	X	X	X	___	___	___
g. Field assembled couplings aligned to meet manufacturer's prescribed tolerances.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to pump disconnect.	___	___	___	X	X	___	___	___
b. Pump rotation verified.	___	___	___	X	X	___	___	___
c. Control system interlocks functional.	___	___	___	X	___	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Pressure/temperature gauges installed.	___	___	X	___	X	___	___	___
b. Piping system cleaned.	___	___	X	X	X	___	___	___
c. Chemical water treatment complete.	___	___	X	X	X	___	___	___
d. Water balance complete.	___	___	X	___	X	___	___	___
e. Water balance with design maximum flow.	___	___	X	___	X	___	___	___
f. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Packaged Air Cooled Chiller

For Chiller: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Chiller properly piped.	___	___	X	___	___	___	___	___
b. Chilled water pipe leak tested.	___	___	X	X	X	___	___	___
c. Verify that refrigerant used complies with specified requirements.	___	___	X	X	X	___	___	___
d. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
e. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Separate power is supplied to electric heating tape.	___	___	___	X	___	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Controls								
a. Factory startup and checkout complete.	___	___	X	X	___	___	___	___
b. Chiller safety/protection devices tested.	___	___	X	X	___	___	___	___
c. Chilled water flow switch installed.	___	___	X	X	___	___	___	___
d. Chilled water flow switch tested.	___	___	X	X	___	___	___	___
e. Chilled water pump interlock installed.	___	___	X	X	X	___	___	___
f. Chilled water pump interlock tested.	___	___	___	X	___	___	___	___

Pre-commissioning Checklist - Centrifugal Chiller

For Chiller: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Chilled water connections properly piped.			X					
b. Condenser water connections properly piped			X					
c. Chilled water pipe leak tested.			X	X	X			
d. Condenser water pipe leak tested.			X	X	X			
e. High efficiency purge unit installed and operating as specified.			X	X	X			
f. Refrigerant leak detector installed.								
g. Oxygen sensor installed and tested.								
h. Mechanical room ventilation installed as specified.								
i. Manufacturer's required maintenance clearance provided.			X	X				
j. Field assembled couplings aligned to meet manufacturer's prescribed tolerances.			X	X	X			
Electrical								
a. Power available to unit starter.				X				
b. Power available to unit control panel.				X				
c. Verify that power disconnect is located within sight of the unit it controls.				X				
Controls								
a. Factory startup and checkout complete.			X	X				
b. Chiller safety/protection devices tested.				X				
c. Chilled water flow switch installed.			X	X				
d. Chilled water flow switch tested.			X	X				
e. Chilled water pump interlock installed.				X				
f. Chilled water pump interlock tested.				X				
g. Condenser water flow switch installed.			X					
h. Condenser water flow switch tested.				X				

Pre-commissioning Checklist - Centrifugal Chiller

For Chiller: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
i. Condenser water pump interlock installed.	___	___	___	X	___	___	___	___
j. Condenser water pump interlock tested.	___	___	___	X	___	___	___	___

Pre-commissioning Checklist - Cooling Tower

For Cooling Tower: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Cooling tower in place.	___	___	X	___	___	___	___	___
b. Cooling tower piped.	___	___	X	X	___	___	___	___
c. Cooling tower fan drive adjusted.	___	___	___	___	X	___	___	___
d. Cooling tower makeup water supply piped.	___	___	X	X	___	___	___	___
e. Verify makeup control valve shutoff.	___	___	X	___	X	___	___	___
f. Fan lubricated and blade pitch adjusted.	___	___	X	___	X	___	___	___
g. Manufacturer's required maintenance/ operational clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to tower disconnect.	___	___	___	X	___	___	___	___
b. Power available to electric sump heater.	___	___	___	X	___	___	___	___
c. Control system interlocks functional.	___	___	___	X	___	___	___	___
d. Motor and fan rotation checked.	___	___	___	X	___	___	___	___
e. Verify that power disconnect is located within sight of the unit is controls.	___	___	___	X	___	___	___	___
Piping								
a. Tower basin is clean and filled.	___	___	X	X	X	___	___	___
b. Condenser water treatment functional.	___	___	X	X	X	___	___	___
c. Water balance with design flow verified.	___	___	X	___	X	___	___	___
d. Water distribution headers balanced.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Hot Water Boiler

For Boiler: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Boiler flue installed.			X					
b. Boiler hot water piping installed.			X					
c. Boiler hot water piping tested.			X	X				
d. Boiler makeup water piping installed.			X					
e. Boiler fuel oil piping installed.			X	X	X			
f. Boiler fuel oil piping tested.			X	X	X			
g. Boiler gas piping installed.			X	X	X			
h. Boiler gas piping tested.			X	X	X			
i. Manufacturer's required maintenance clearance provided.			X					
Startup								
a. Boiler system cleaned and filled with treated water.			X					
b. Boiler safety/protection devices, including high temperature burner shut-off, low water cutoff, flame failure, pre and post purge, have been tested.				X				
c. Verify that PRV rating conforms to boiler rating.				X				
d. Boiler water treatment system functional.			X	X				
e. Boiler startup and checkout complete.			X	X				
f. Combustion efficiency demonstrated.			X		X			
Electrical								
a. Verify that power disconnect is located within sight of the unit served.				X				
Controls								
a. Hot water pump interlock installed.				X				
b. Hot water pump interlock tested.				X				
c. Hot water heating system balanced.			X	X				

Pre-commissioning Checklist - Hot Water Boiler

For Boiler: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
d. Hot water heating controls operational.	___	___	X	X	___	___	___	___

Pre-commissioning Checklist - Steam Boiler

For Boiler: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Boiler flue installed.	___	___	X	X	X	___	___	___
b. Boiler steam piping installed.	___	___	X	X	X	___	___	___
c. Boiler steam piping tested.	___	___	X	X	X	___	___	___
d. Boiler makeup water piping installed.	___	___	X	___	X	___	___	___
e. Boiler makeup water piping tested.	___	___	X	X	X	___	___	___
f. Boiler fuel oil piping installed.	___	___	X	X	X	___	___	___
g. Boiler fuel oil piping tested.	___	___	X	X	X	___	___	___
h. Boiler gas piping installed.	___	___	X	X	X	___	___	___
i. Boiler gas piping tested.	___	___	X	X	X	___	___	___
j. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Startup								
a. Boiler system cleaned and filled with treated water.	___	___	X	X	X	___	___	___
b. Boiler safety/protection devices, including high temperature burner shut-off, low water cutoff, flame failure, pre and post purge, have been tested.	___	___	___	X	___	___	___	___
c. Verify that PRV rating conforms to boiler rating.	___	___	___	X	___	___	___	___
d. Boiler feed water system operational.	___	___	___	X	___	___	___	___
e. Boiler water treatment system functional.	___	___	X	X	X	___	___	___
f. Boiler startup and checkout complete.	___	___	___	X	___	___	___	___
g. All steam traps operational.	___	___	X	X	X	___	___	___
h. All condensate return pumps operational.	___	___	___	___	X	___	___	___
i. Combustion efficiency demonstrated.	___	___	X	___	X	___	___	___
Electrical								
a. Verify that power disconnect is located within sight of the unit served.	___	___	___	X	___	___	___	___

Pre-commissioning Checklist - Steam/Hot Water Converter

For Converter: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Converter steam piping installed.	___	___	X	___	X	___	___	___
b. Converter steam piping tested.	___	___	X	X	X	___	___	___
c. Hot water piping installed.	___	___	X	___	___	___	___	___
d. Hot water piping tested.	___	___	X	X	X	___	___	___
e. Makeup water piping installed.	___	___	X	X	X	___	___	___
f. Vacuum breaker installed on shell of shell and tube unit.	___	___	X	X	X	___	___	___
g. Air vent installed as specified.	___	___	X	X	X	___	___	___
h. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Startup								
a. Hot water system cleaned and filled.	___	___	X	X	X	___	___	___
b. All steam traps operational.	___	___	X	X	X	___	___	___
c. All condensate return pumps operational.	___	___	___	X	___	___	___	___
d. Converter safety/protection devices tested.	___	___	X	X	X	___	___	___
e. Converter startup and checkout complete.	___	___	X	X	X	___	___	___
Controls								
a. Control valves/actuators properly installed.	___	___	X	___	___	___	___	___
b. Control valves/actuators operable.	___	___	X	___	___	___	___	___

Pre-commissioning Checklist - Fan Coil Unit

For Fan Coil Unit: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Vibration isolation devices installed.	___	___	X	X	X	___	___	___
b. Access doors/removable panels are operable and sealed.	___	___	X	___	X	___	___	___
c. Casing undamaged.	___	___	X	X	X	___	___	___
d. Insulation undamaged.	___	___	X	X	X	___	___	___
e. Condensate drainage is unobstructed.	___	___	X	X	X	___	___	___
f. Fan belt adjusted.	___	___	X	___	X	___	___	___
g. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
h. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
[e. Power available to electric heating coil.	___	___	___	X	X	___	___	___]
Coils								
[a. Dual temperature piping properly connected.	___	___	X	___	___	___	___	___]
[a. Chilled water piping properly connected.	___	___	X	X	X	___	___	___]
[b. Dual temperature piping pressure tested.	___	___	X	___	___	___	___	___]
[b. Chilled water piping pressure tested.	___	___	X	X	X	___	___	___]
[c. Hot water piping properly connected.	___	___	X	___	___	___	___	___]
[d. Hot water piping pressure tested.	___	___	X	___	___	___	___	___]
Controls								
a. Control valves/actuators properly installed.	___	___	X	___	___	___	___	___

Pre-commissioning Checklist - Fan Coil Unit

For Fan Coil Unit: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
b. Control valves/actuators operable.	___	___	X	X	___	___	___	___
c. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Construction filters removed and replaced.	___	___	X	___	___	___	___	___
b. TAB results +10%/-0% of cfm shown on drawings								
c. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Unit Heater

For Unit Heater: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
[a. Hot water piping properly connected.	___	___	X	___	___	___	___	___]
[a. Steam and condensate piping properly connected.	___	___	X	X	X	___	___	___]
[b. Hot water piping pressure tested.	___	___	X	___	___	___	___	___]
[b. Steam and condensate piping pressure tested.	___	___	X	X	X	___	___	___]
c. Air vent installed on hot water coil with shutoff valve as specified.	___	___	X	X	X	___	___	___
d. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
e. Manufacturer's required maintenance/ operational clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	X	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
d. Power available to electric heating coil.	___	___	___	X	___	___	___	___
Controls								
a. Control valves properly installed.	___	___	X	___	___	___	___	___
b. Control valves operable.	___	___	X	X	___	___	___	___
c. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Exhaust Fan

For Exhaust Fan: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Fan belt adjusted.	___	___	X	___	X	___	___	___
Electrical								
a. Power available to fan disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Controls								
a. Control interlocks properly installed.	___	___	___	X	___	___	___	___
b. Control interlocks operable.	___	___	___	X	___	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___	___	___
e. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB results +10%/-0% to cfm shown on drawings	___	___	X	___	X	___	___	___
b. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Computer Room Unit

For Computer Room Unit: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Unit properly supported.	___	___	X	X	X	___	___	___
b. Access doors are operable and sealed.	___	___	X	___	X	___	___	___
c. Casing undamaged.	___	___	X	X	X	___	___	___
d. Insulation undamaged.	___	___	X	X	X	___	___	___
e. Condensate drainage is unobstructed and routed to floor drain.	___	___	X	X	X	___	___	___
f. Fan belt adjusted.	___	___	X	___	X	___	___	___
g. Manufacturer's required maintenance operational clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	X	___	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
[e. Power available to reheat coils.	___	___	___	___	X	___	___	___]
Coils/Humidifier								
[a. Chilled water piping properly connected.	___	___	X	___	___	___	___	___]
[a. Refrigerant piping properly connected.	___	___	X	X	X	___	___	___]
[b. Chilled water piping pressure tested.	___	___	X	X	X	___	___	___]
[b. Refrigerant piping pressure tested.	___	___	X	X	X	___	___	___]
[c. Hot water piping properly connected.	___	___	X	___	___	___	___	___]
[c. Steam piping properly connected.	___	___	X	X	X	___	___	___]
[d. Hot water piping pressure tested.	___	___	X	X	___	___	___	___]
[d. Steam piping pressure tested.	___	___	X	X	X	___	___	___]
e. Humidifier makeup water connected.	___	___	X	X	X	___	___	___
Controls								

Pre-commissioning Checklist - Computer Room Unit

For Computer Room Unit: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
a. Control valves operable.	___	___	X	X	___	___	___	___
b. Unit control system operable and verified.	___	___	___	X	___	___	___	___
c. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___

Testing, Adjusting, and Balancing (TAB)

	Q	M	E	T	C	D	O	U
a. Construction filters removed and replaced.	___	___	X	___	X	___	___	___
b. TAB results +10%/-0% cfm shown on drawings.	___	___	X	___	X	___	___	___
c. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - HVAC System Controls

For HVAC System: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. As-built shop drawings submitted.	___	___	X	X	___	___	___	___
b. Layout of control panel matches drawings.	___	___	X	X	___	___	___	___
c. Framed instructions mounted in or near control panel.	___	___	X	X	___	___	___	___
d. Components properly labeled (on inside and outside of panel).	___	___	X	X	___	___	___	___
e. Control components piped and/or wired to each labeled terminal strip.	___	___	X	X	___	___	___	___
f. EMCS connection made to each labeled terminal strip as shown.	___	___	X	X	___	___	___	___
g. Control wiring and tubing labeled at all terminations, splices, and junctions.	___	___	X	X	___	___	___	___
h. Shielded wiring used on electronic sensors.	__	__	X	X	___	___	___	___
i. Air dryer installed as specified.	___	___	X	X	___	___	___	___
j. Water drain installed as specified.	___	___	X	X	___	___	___	___
Main Power and Control Air								
a. 110 volt AC power available to panel.	___	___	___	X	___	___	___	___
b. 20 psig compressed air available to panel.	___	___	X	X	___	___	___	___
Testing, Commissioning, and Balancing								
a. Testing, Commissioning, and Balancing Report submitted.	___	___	X	___	___	___	___	___

Pre-commissioning Checklist - Single Zone Air Handling Unit

For Air Handling Unit: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Vibration isolation devices installed.			X	X	X			
b. Inspection and access doors are operable and sealed.			X		X			
c. Casing undamaged.			X	X	X			
d. Insulation undamaged.			X	X	X			
e. Condensate drainage is unobstructed.			X	X	X			
f. Fan belt adjusted.			X		X			
g. Any damage to coil fins has been repaired.			X		X			
h. Manufacturer's required maintenance clearance provided.			X	X	X			
Electrical								
a. Power available to unit disconnect.				X	X			
b. Power available to unit control panel.				X				
c. Proper motor rotation verified.					X			
d. Verify that power disconnect is located within sight of the unit it controls.				X				
e. Power available to electric heating coil.				X				
Coils								
[a. Chilled water piping properly connected.			X					]
[a. Refrigerant piping properly connected.			X	X	X			]
[b. Chilled water piping pressure tested.			X	X	X			]
[b. Refrigerant piping pressure tested.			X	X	X			]
[c. Hot water piping properly connected.			X					]
[c. Steam and condensate piping properly connected.			X	X	X			]
[d. Hot water piping pressure tested.			X	X				]
[d. Steam and condensate piping pressure tested.			X	X	X			]

Pre-commissioning Checklist - Single Zone Air Handling Unit

For Air Handling Unit: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
[e. Air vents installed on water coils [with shutoff valves] as specified.	___	___	X	X	X	__	___	___]
f. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
Controls								
a. Control valves/actuators properly installed.	___	___	X	___	___	___	___	___
b. Control valves/actuators operable.	___	___	X	___	___	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___	___	___
e. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Construction filters removed and replaced.	___	___	X	___	X	___	___	___
b. TAB results +10%/-0% cfm shown on drawings.	___	___	X	___	X	___	___	___
c. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Energy Recovery System

For Energy Recovery System: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Recovery system piping installed.	___	___	X	___	X	___	___	___
b. Recovery system piping tested.	___	___	X	X	X	___	___	___
c. Air vent installed as specified.	___	___	X	X	X	___	___	___
d. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Startup								
a. Recovery system piping cleaned and filled.	___	___	X	X	X	___	___	___
b. Converter startup and checkout complete.	___	___	X	X	X	___	___	___
Controls								
a. Control valves/actuators properly installed.	___	___	X	___	___	___	___	___
b. Control valves/actuators operable.	___	___	X	___	___	___	___	___

APPENDIX B

FUNCTIONAL PERFORMANCE TESTS CHECKLISTS

Functional Performance Test Checklist - Pumps

For Pump: [_____]

Prior to performing this checklist, ensure that for closed loop systems, system is pressurized and the make-up water system is operational or, for open loop systems, that the sumps are filled to the proper level.

1. Activate pump start using control system commands (all possible combination, on/auto, etc.). ON__________ AUTO__________ OFF__________

a. Verify pressure drop across strainer:

Strainer inlet pressure __________ psig
Strainer outlet pressure _________ psig

b. Verify pump inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report, pump design conditions, and pump manufacturer's performance.

	DESIGN	TAB	ACTUAL
Pump inlet pressure (psig)	___________	__________	__________
Pump outlet pressure (psig)	___________	__________	__________

c. Operate pump at shutoff and at 100 percent of designed flow when all components are in full flow. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

	SHUTOFF	100 percent
Pump inlet pressure (psig)	__________	__________
Pump outlet pressure	__________	__________
Pump flow rate (gpm)	__________	__________

d. Operate pump at shutoff and at minimum flow or when all components are in full by-pass. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

	SHUTOFF	100 percent
Pump inlet pressure (psig)	__________	__________
Pump outlet pressure	__________	__________
Pump flow rate (gpm)	__________	__________

2. Verify motor amperage each phase and voltage phase to phase and phase to ground for both the full flow and the minimum flow conditions.

a. Full flow:

	PHASE 1	PHASE 2	PHASE 3
Amperage	__________	__________	__________
Voltage	__________	__________	
Voltage	________________________		
Voltage to ground	__________	__________	__________

b. Minimum flow:

Functional Performance Test Checklist - Pumps

For Pump: [_____]

	PHASE 1	PHASE 2	PHASE 3
Amperage	___________	___________	___________
Voltage	___________	___________	
Voltage	___________________________		
Voltage to ground	___________	___________	___________

3. Unusual vibration, noise, etc.

____

____

4. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

	Signature and Date
Contractor's Chief Quality Control Representative	_____________________________
Contractor's Mechanical Representative	_____________________________
Contractor's Electrical Representative	_____________________________
Contractor's Testing, Adjusting and Balancing Representative	_____________________________
Contractor's Controls Representative	_____________________________
Contracting Officer's Representative	_____________________________
Using Agency's Representative	_____________________________

Functional Performance Test Checklist - Centrifugal Chiller

For Chiller: [_____]

1. Functional Performance Test: Contractor shall demonstrate operation of chilled water system as per specifications including the following: Start building air handler to provide load for chiller. Activate controls system chiller start sequence as follows:

a. Time of day startup program initiates chiller start: ____________

b. Start condenser water pump and establish condenser water flow. Verify chiller condenser water proof-of-flow switch operation. ____________

c. Start chilled water pump and establish chilled water flow. Verify chiller chilled water proof-of-flow switch operation. ____________________

d. Verify control system energizes chiller start sequence. __________

e. Verify chiller senses chilled water temperature above set point and control system activates chiller start. __________________________________

f. Verify functioning of "soft start" sequence. _____________________

g. Shut off air handling equipment to remove load on chilled water system. Verify chiller shutdown sequence is initiated and accomplished after load is removed. _______________________

h. Restart air handling equipment one minute after chiller shut down. Verify condenser water pump, cooling tower, and chiller restart sequence.
____

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

	Signature and Date
Contractor's Chief Quality Control Representative	_____________________________
Contractor's Mechanical Representative	_____________________________
Contractor's Electrical Representative	_____________________________
Contractor's Testing, Adjusting and Balancing Representative	_____________________________
Contractor's Controls Representative	_____________________________
Contracting Officer's Representative	_____________________________
Using Agency's Representative	_____________________________

Functional Performance Test Checklist - Cooling Tower

For Cooling Tower: [_____]

1. Functional Performance Test: Contractor shall demonstrate operation of the cooling tower as per specification and the following:

a. Activate cooling tower fan start using control system command. This should first start condenser water pump, establish flow, delay fan start, as specified, to equalize flow in distribution basin and sump. Verify fan start after timed delay. ______________________________________

b. After chiller startup, control system should modulate bypass valve and two-speed fan motor to maintain condenser water set point. Verify function of bypass valve under varying loads. ____________________________

c. Verify cooling tower interlock with chiller. ____________________

d. Verify makeup water float valve is functioning: ___________________
Activate chemical treatment feed valve, verify makeup of chemical treatment system, pump, and controls: ____

e. Entering water temperature [_____] degrees F
Leaving water temperature: [_____] degrees F
Air volume measured: [_____] cfm
Air volume calculated: [_____] cfm
Entering wet bulb temperature: [_____] degrees F
Measured water flow: [_____] gpm

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative _____________________________

Contractor's Mechanical Representative _____________________________

Contractor's Electrical Representative _____________________________

Contractor's Testing, Adjusting and Balancing Representative _____________________________

Contractor's Controls Representative _____________________________

Contracting Officer's Representative _____________________________

Using Agency's Representative _____________________________

Functional Performance Test Checklist - VAV Terminals

The Contracting officer will select VAV terminals to be spot-checked during the functional performance test. The number of terminals shall not exceed [2] [10] [10 percent].

1. Functional Performance Test: Contractor shall demonstrate operation of selected VAV boxes as per specifications including the following:

a. Cooling only VAV boxes:

(1) Verify VAV box response to room temperature set point adjustment. Turn thermostat to 5 degrees F above ambient and measure maximum air flow. Turn thermostat to 5 degrees F below ambient and measure minimum air flow.

Maximum flow [_____] cfm
Minimum flow [_____] cfm

(2) Check damper maximum/minimum flow settings.

Maximum flow setting [_____] cfm
Minimum flow setting [_____] cfm

b. Cooling with reheat VAV boxes:

(1) Verify VAV box response to room temperature set point adjustment. Turn thermostat to 5 degrees F above ambientand measure maximum air flow. Turn thermostat to 5 degrees F below ambient and measure minimum air flow.

Maximum flow [_____] cfm
Minimum flow [_____] cfm

(2) Check damper maximum/minimum flow settings.

Maximum flow setting [_____] cfm
Minimum flow setting [_____] cfm

Reheat coil operation range (full open to full closed) __________________

c. Fan powered VAV boxes:

(1) Verify VAV box response to sensor call for heating via set point adjustment. Changes to be cooling setpoint to heating set point and return to cooling set point. __________ Verify cooling damper closes to minimum position, blower fan energizes according to sequence of operation, and upon further drop in space temperature, heating coil activation and deactivation. __________

(2) Check primary air damper maximum/minimum flow settings.

Maximum flow setting [_____] cfm
Minimum flow setting [_____] cfm

(3) Check blower fan flow. [_____] cfm

(4) Verify free operation of fan backdraft damper (insure no primary air is being discharged through the recirculated air register).

___

(5) Verify that no recirculated air is being induced when box is in full cooling. ___

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

	Signature and Date
Contractor's Chief Quality Control Representative	___
Contractor's Mechanical Representative	___
Contractor's Electrical Representative	___
Contractor's Testing, Adjusting and Balancing Representative	___
Contractor's Controls Representative	___
Contracting Officer's Representative	___
Using Agency's Representative	___

Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: [_____]

Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions.

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. The following shall be verified when the [supply fan operating] [supply and return fans operating] mode is initiated:

(1) All dampers in normal position [and fan inlet vanes modulate to maintain the required static pressure]. ______________________________

(2) All valves in normal position. ______________________________

(3) System safeties allow start if safety conditions are met. _____

(4) VAV fan controller shall "soft-start" fan. ____________________

(5) Modulate all VAV boxes to minimum air flow and verify that the static pressure does not exceed the design static pressure Class shown.
____

b. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position. ______________________

(2) Return air damper open. ______________________________

(3) Relief air damper [at minimum position] [closed]. ____________

(4) Chilled water control valve modulating to maintain leaving air temperature set point. ______________________________

(5) Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure set point.
____

c. Occupied mode of operation - economizer energized.

(1) Outside air damper modulated to maintain mixed air temperature set point. ______________________________

(2) Relief air damper modulates with outside air damper according to sequence of operation. ______________________________

(3) Chilled water control valve modulating to maintain leaving air temperature set point. ______________________________

(4) Hot water control valve modulating to maintain leaving air temperature set point. ______________________________

(5) Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure set point.

d. Unoccupied mode of operation

(1) All dampers in normal position. ______________________________

(2) Verify low limit space temperature is maintained as specified in sequence of operation. ____

e. The following shall be verified when the [supply fan off] [supply and return fans off] mode is initiated:

(1) All dampers in normal position. ______________________________

(2) All valves in normal position. ______________________________

(3) Fan de-energizes. ____

f. Verify the chilled water coil control valve operation by setting all VAV's to maximum and minimum cooling.

	Max cooling	Min cooling
Supply air volume _____ cfm)	__________	___________
Supply air temp. (_____ degrees F)	__________	___________

g. Verify safety shut down initiated by smoke detectors. ____________

h. Verify safety shut down initiated by low temperature protection thermostat. ____

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

	Signature and Date
Contractor's Chief Quality Control Representative	______________________________
Contractor's Mechanical Representative	______________________________
Contractor's Electrical Representative	______________________________
Contractor's Testing, Adjusting and Balancing Representative	______________________________
Contractor's Controls Representative	______________________________
Contracting Officer's Representative	______________________________
Using Agency's Representative	______________________________

Functional Performance Test Checklist - Single Zone Air Handling Unit

For Air Handling Unit: [_____]

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. The following shall be verified when the [supply fan operating] [supply and return fans operating] mode is initiated:

(1) All dampers in normal position. ______________________________

(2) All valves in normal position. ______________________________

(3) System safeties allow start if safety conditions are met. _____

b. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position. ______________________

(2) Return air damper open. ______________________________________

(3) Relief air damper [at minimum position] [closed]. ____________

(4) Chilled water control valve modulating to maintain space cooling temperature set point. ____

(5) Hot water control valve modulating to maintain space heating temperature set point input from outside air temperature controller. ________

c. Occupied mode of operation - economizer energized.

(1) Outside air damper modulated to maintain mixed air temperature set point. ____

(2) Relief air damper modulates with outside air damper according to sequence of operation. ____

(3) Chilled water control valve modulating to maintain space cooling temperature set point. ____

d. Unoccupied mode of operation

(1) All dampers in normal position. ______________________________

(2) Verify low limit space temperature is maintained as specified in sequence of operation. ____

e. The following shall be verified when the [supply fan off] [supply and return fans off] mode is initiated:

(1) All dampers in normal position. ______________________________

(2) All valves in normal position. _______________________________

(3) Fan de-energizes. ____

f. Verify cooling coil and heating coil operation by varying thermostat set point from cooling set point to heating set point and returning to cooling set point. ____

g. Verify safety shut down initiated by smoke detectors. _____________

h. Verify safety shut down initiated by low temperature protection thermostat. ____

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative ______________________________

Contractor's Mechanical Representative ______________________________

Contractor's Electrical Representative ______________________________

Contractor's Testing, Adjusting and Balancing Representative ______________________________

Contractor's Controls Representative ______________________________

Contracting Officer's Representative ______________________________

Using Agency's Representative ______________________________

Functional Performance Test Checklist - Multizone Air Handling Unit

For Air Handling Unit: [_____]

Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions.

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. The following shall be verified when the supply and return fans operating mode is initiated:

(1) All dampers in normal position. ________________________________

(2) All valves in normal position. _________________________________

(3) System safeties allow start if safety conditions are met. _____

b. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position. ________________________

(2) Return air damper open. ____

(3) Relief air damper [at minimum position] [closed]. ______________

(4) Chilled water control valve modulating to maintain cold deck supply air temperature set point. ____

(5) Hot water control valve modulating to maintain hot deck supply air temperature set point input from outside air temperature controller. ____

c. Occupied mode of operation - economizer energized.

(1) Outside air damper modulates to maintain mixed air temperature set point. ____

(2) Relief air damper modulates with outside air damper according to sequence of operation. ____

(3) Chilled water control valve modulating to maintain cold deck supply air temperature set point. ____

(4) Hot water control valve modulating to maintain hot deck supply air temperature set point input from outside air temperature controller. ____

d. Unoccupied mode of operation

(1) All dampers in normal position. ______________________________

(2) Verify low limit space temperature is maintained as specified in sequence of operation. ____

e. The following shall be verified when the supply and return fans off

Functional Performance Test Checklist - Multizone Air Handling Unit

For Air Handling Unit: [_____]
mode is initiated:

(1) All dampers in normal position. ______________________________

(2) All valves in normal position. _______________________________

(3) Fan de-energizes. ____

f. Verify zone damper operation by varying zone thermostat set points from cooling set point to heating set point and returning to cooling set point. ____

g. Verify safety shut down initiated by smoke detectors. ____________

h. Verify safety shut down initiated by low temperature protection thermostat. ____

i. Index room thermostats to full cooling then to full heating. Measure and record cold deck, hot deck, and supply air temperatures and determine damper leakage for a minimum of 2 zones.

Cold deck temperature _____ degrees F
Hot deck temperature _____ degrees F

Zone ________
Cooling temperature _______ degrees F
Heating temperature _______ degrees F
Damper leakage cooling ____ degrees F
Damper leakage heating ____ degrees

Zone ________
Cooling temperature _______ degrees F
Heating temperature _______ degrees F
Damper leakage cooling ____ degrees F
Damper leakage heating ____ degrees F

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative ______________________________

Contractor's Mechanical Representative ______________________________

Contractor's Electrical Representative ______________________________

Contractor's Testing, Adjusting and Balancing Representative

Functional Performance Test Checklist - Multizone Air Handling Unit

For Air Handling Unit: [_____]

Contractor's Controls Representative ______________________________

Contracting Officer's Representative ______________________________

Using Agency's Representative ______________________________

Functional Performance Test Checklist - Packaged Air Cooled Chiller

For Chiller: [_____]

1. Functional Performance Test: Contractor shall demonstrate operation of chilled water system as per specifications including the following: Start building air handler to provide load for chiller. Activate controls system chiller start sequence as follows.

a. Start chilled water pump and establish chilled water flow. Verify chiller-chilled water proof-of-flow switch operation. ____________________

b. Verify control system energizes chiller start sequence. ___________

c. Verify chiller senses chilled water temperature above set point and control system activates chiller start. __________________________________

d. Verify functioning of "soft start" sequence. ______________________

e. Shut off air handling equipment to remove load on chilled water system. Verify chiller shutdown sequence is initiated and accomplished after load is removed. ____

f. Restart air handling equipment one minute after chiller shut down. Verify chiller restart sequence. ____

2. Verify chiller inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report, chiller design conditions, and chiller manufacturer's performance data.

	DESIGN	TAB	ACTUAL
Chiller inlet pressure (psig)	__________	__________	__________
Chiller outlet pressure (psig)	__________	__________	__________

3. Verify chiller amperage each phase and voltage phase-to-phase and phase-to-ground.

	PHASE 1	PHASE 2	PHASE 3
Amperage	__________	__________	__________
Voltage	__________	__________	
Voltage		______________________	
Voltage to ground	__________	__________	__________

4. Record the following information:

Ambient dry bulb temperature ___________ degrees F
Ambient wet bulb temperature ___________ degrees F
Entering chilled water temperature _____ degrees F
Leaving chilled water temperature ______ degrees F

5. Unusual vibration, noise, etc.
____

____

Functional Performance Test Checklist - Packaged Air Cooled Chiller

For Chiller: [_____]

6. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

	Signature and Date
Contractor's Chief Quality Control Representative	______________________
Contractor's Mechanical Representative	______________________
Contractor's Electrical Representative	______________________
Contractor's Testing, Adjusting and Balancing Representative	______________________
Contractor's Controls Representative	______________________
Contracting Officer's Representative	______________________
Using Agency's Representative	______________________

Functional Performance Test Checklist - Air Cooled Condensing Unit

For Condensing Unit: [_____]

1. Functional Performance Test: Contractor shall demonstrate operation of refrigeration system as per specifications including the following: Start building air handler to provide load for condensing unit. Activate controls system start sequence as follows.

a. Start air handling unit. Verify control system energizes condensing unit start sequence. ____

b. Shut off air handling equipment to verify condensing unit de-energizes. ____

c. Restart air handling equipment one minute after condensing unit shut down. Verify condensing unit restart sequence. ________________________

2. Verify condensing unit amperage each phase and voltage phase to phase and phase to ground.

	PHASE 1	PHASE 2	PHASE 3
Amperage	__________	__________	__________
Voltage	__________	__________	
Voltage	______________________		
Voltage to ground	__________	__________	__________

3. Record the following information:

Ambient dry bulb temperature	________	degrees F
Ambient wet bulb temperature	________	degrees F
Suction pressure	________	psig
Discharge pressure	________	psig

4. Unusual vibration, noise, etc.
____

____

5. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative
____

Contractor's Mechanical Representative _____________________________

Contractor's Electrical Representative Representative
____

Contractor's Testing, Adjusting and Balancing _____________________________

Functional Performance Test Checklist - Air Cooled Condensing Unit

For Condensing Unit: [_____]

Contractor's Controls Representative ______________________________

Contracting Officer's Representative ______________________________

Using Agency's Representative ______________________________

Functional Performance Test Checklist - Hot Water Boiler

For Boiler: [_____]

1. Functional Performance Test: Contractor shall demonstrate operation of hot water system as per specifications including the following: Start building heating equipment to provide load for boiler. Activate controls system boiler start sequence as follows.

a. Start hot water pump and establish hot water flow. Verify boiler hot water proof-of-flow switch operation. ______________________________

b. Verify control system energizes boiler start sequence. ___________

c. Verify boiler senses hot water temperature below set point and control system activates boiler start. ___________________________________

d. Shut off building heating equipment to remove load on hot water system. Verify boiler shutdown sequence is initiated and accomplished after load is removed. ____

2. Verify boiler inlet/outlet pressure reading, compare to Test and Balance (TAB) Report, boiler design conditions, and boiler manufacturer's performance data.

	DESIGN	TAB	ACTUAL
Boiler inlet pressure (psig)	__________	__________	__________
Boiler outlet pressure (psig)	__________	__________	__________
Boiler flow rate (gpm)	__________	__________	__________
Flue-gas temperature at boiler outlet		__________	__________
Percent carbon dioxide in flue-gas		__________	__________
Draft at boiler flue-gas exit		__________	__________
Draft or pressure in furnace		__________	__________
Stack emission pollutants concentration	__________	__________	__________
Fuel type	__________	__________	__________
Combustion efficiency	__________	__________	__________

3. Record the following information:

Ambient temperature	__________	degrees F
Entering hot water temperature	__________	degrees F
Leaving hot water temperature	__________	degrees F

4. Verify temperatures in item 3 are in accordance with the reset schedule. ____

5. Verify proper operation of boiler safeties. __________________________

6. Unusual vibration, noise, etc.

____

Functional Performance Test Checklist - Hot Water Boiler

For Boiler: [_____]

7. Visually check refractory for cracks or spalling and refractory and tubes for flame impingement.   ______________________________

8. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative
____

Contractor's Mechanical Representative   ______________________________

Contractor's Electrical Representative   ______________________________

Contractor's Testing, Adjusting and Balancing Representative
____

Contractor's Controls Representative   ______________________________

Contracting Officer's Representative   ______________________________

Using Agency's Representative   ______________________________

Functional Performance Test Checklist - Steam Boiler

For Boiler: [_____]

1. Functional Performance Test: Contractor shall demonstrate operation of steam heating system as per specifications including the following: Start building heating equipment to provide load for boiler. Activate controls system boiler start sequence as follows.

a. Start steam heating system. Verify control system energizes boiler start sequence. ____

b. Verify boiler senses steam pressure below set point and control system activates boiler start. ____

c. Shut off building heating equipment to remove load on steam heating system. Verify boiler shutdown sequence is initiated and accomplished after load is removed. ____

d. Verify that water level and makeup water system are operational.

____

2. Verify boiler inlet/outlet pressure reading, compare to boiler design conditions and manufacturer's performance data.

	DESIGN	TAB	ACTUAL
Boiler inlet water temp (degrees F)	__________	__________	__________
Boiler outlet pressure (psig)	__________	__________	__________
Flue-gas temperature at boiler outlet (degrees F)		__________	__________
Percent carbon dioxide in flue-gas		__________	__________
Draft at boiler flue-gas exit		__________	__________
Draft or pressure in furnace		__________	__________
Stack emission pollutants concentration	__________	__________	__________
Fuel type	__________	__________	__________
Combustion efficiency	__________	__________	__________

3. Record the following information:

Ambient temperature
Ambient temperature __________ degrees F

4. Verify proper operation of boiler safeties. __________________________

5. Unusual vibration, noise, etc.

____

____

6. Visually check refractory for cracks or spalling and refractory and tubes for flame impingement. ____

7. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Functional Performance Test Checklist - Steam Boiler

For Boiler: [_____]

	Signature and Date
Contractor's Chief Quality Control Representative	______________________________
Contractor's Mechanical Representative	______________________________
Contractor's Electrical Representative	______________________________
Contractor's Testing, Adjusting and Balancing Representative	______________________________
Contractor's Controls Representative	______________________________
Contracting Officer's Representative	______________________________
Using Agency's Representative	______________________________

Functional Performance Test Checklist - Fan Coil Units

The Contracting Officer will select fan coil units to be spot-checked during the functional performance test. The number of terminals shall not exceed [2] [10] [10 percent].

1. Functional Performance Test: Contractor shall demonstrate operation of selected fan coils as per specifications including the following:

a. Cooling only fan coils:

(1) Verify fan coil unit response to room temperature set point adjustment. Changes to be cooling set point to cooling set point minus 10 degrees and return to cooling set point. ___________________________________

(2) Check blower fan air flow.
Check blower fan air flow. _____ cfm

(3) Check cooling coil water flow.
Check cooling coil water flow. _____ gpm

(4) Verify proper operation of cooling water control valve. ______

b. Cooling/heating fan coils:

(1) Verify fan coil unit response to room temperature set point adjustment. Changes to be cooling set point to heating set point and return to cooling set point. ____

(2) Check blower fan air flow.
Check blower fan air flow. _____ cfm

(3) Check cooling coil water flow.
Check cooling coil water flow. _____ cfm

(4) Verify proper operation of cooling water control valve. _____

(5) Check cooling mode inlet air temperature.
Check cooling mode inlet air temperature. _____ degrees F

(6) Check cooling mode outlet air temperature.
Check cooling mode outlet air temperature. _____ degrees F

(7) Check heating coil water flow.
Check heating coil water flow. _____ gpm

(8) Verify proper operation of heating water control valve. _____

(9) Check heating mode inlet air temperature.
Check heating mode inlet air temperature. _____ degrees F

(10) Check heating mode outlet air temperature.
Check heating mode outlet air temperature. _____ degrees F

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Functional Performance Test Checklist - Fan Coil Units

Signature and Date

Contractor's Chief Quality Control Representative ______________________________

Contractor's Mechanical Representative ______________________________

Contractor's Electrical Representative ______________________________

Contractor's Testing, Adjusting and Balancing Representative ______________________________

Contractor's Controls Representative ______________________________

Contracting Officer's Representative ______________________________

Using Agency's Representative ______________________________

Functional Performance Test Checklist - Unit Heaters

The Contracting Officer will select unit heaters to be spot-checked during the functional performance test. The number of terminals shall not exceed [2] [10] [10 percent].

1. Functional Performance Test: Contractor shall demonstrate operation of selected unit heaters as per specifications including the following:

a. Verify unit heater response to room temperature set point adjustment. Changes to be heating set point to heating set point minus 10 degrees and return to heating set point. ___________________________________

b. Check blower fan speed. _______________________________________rpm

c. Check heating mode inlet air temperature. Check heating mode inlet air temperature. _____ degrees F

d. Check heating mode outlet air temperature. Check heating mode outlet air temperature. _____ degrees F

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

	Signature and Date
Contractor's Chief Quality Control Representative	_____________________________
Contractor's Mechanical Representative	_____________________________
Contractor's Electrical Representative	_____________________________
Contractor's Testing, Adjusting and Balancing Representative	_____________________________
Contractor's Controls Representative	_____________________________
Contracting Officer's Representative	_____________________________
Using Agency's Representative	_____________________________

Functional Performance Test Checklist - Steam/Hot Water Converter

For Converter: [_____]

1. Functional Performance Test: Contractor shall demonstrate operation of heating system as per specifications including the following: Start building heating equipment to provide load for converter.

a. Verify control system energizes. ______________________________

b. Verify converter senses hot water temperature below set point and control system modulates steam valve. ______________________________

c. Shut off building heating equipment to remove load on heating system. Verify converter steam valve closes after load is removed. ________

2. Verify converter inlet/outlet pressure reading, compare to converter design conditions and manufacturer's performance data.

	DESIGN	ACTUAL
Converter inlet water temp (degrees F)	__________	__________
Converter outlet water temp (degrees F)	__________	__________
Converter inlet steam pressure (psig)	__________	__________
Determine water flow rate based on pressure drop through converter	__________	__________
Determine water flow rate with flow measuring device	__________	__________
Verify that temperature of water is in accordance with outdoor air reset schedule	__________	__________

3. Verify proper operation of converter safeties. ____________________

4. Check and report unusual vibration, noise, etc.

____

____

5. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

	Signature and Date
Contractor's Chief Quality Control Representative	____________________________
Contractor's Mechanical Representative	____________________________
Contractor's Electrical Representative	____________________________
Contractor's Testing, Adjusting and Balancing Representative	____________________________
Contractor's Controls Representative	____________________________
Contracting Officer's Representative	____________________________

Functional Performance Test Checklist - Steam/Hot Water Converter

For Converter: [_____]
Using Agency's Representative ______________________________

Functional Performance Test Checklist - Computer Room Unit

For Computer Room Unit: [_____]

1. Functional Performance Test: Contractor shall verify operation of computer room unit as per specification including the following:

a. System safeties allow start if safety conditions are met. _________

b. Verify cooling and heating operation by varying thermostat set point from space set point to space set point plus 10 degrees, space set point minus 10 degrees, and returning to space set point. ____________________

c. Verify humidifier operation by varying humidistat set point from space set point to space set point plus 20 percent RH, and returning to space set point. ____________________

d. Verify that airflow is within +10/-0 percent of design airflow. ____________________

e. Verify unit shut down during fire event initiated by smoke/heat sensors. ____________________

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

	Signature and Date
Contractor's Chief Quality Control Representative	__________________________
Contractor's Mechanical Representative	__________________________
Contractor's Electrical Representative	__________________________
Contractor's Testing, Adjusting and Balancing Representative	__________________________
Contractor's Controls Representative	__________________________
Contracting Officer's Representative	__________________________
Using Agency's Representative	__________________________

Functional Performance Test Checklist - HVAC Controls

For HVAC System: [_____]

The Contracting Officer will select HVAC control systems to undergo functional performance testing. The number of systems shall not exceed [2] [10] [10 percent].

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the following tests:

a. Verify that controller is maintaining the set point by manually measuring the controlled variable with a thermometer, sling psychrometer, inclined manometer, etc.

b. Verify sensor/controller combination by manually measuring the controlled medium. Take readings from control panel display and compare readings taken manually. Record all readings.

Sensor ____
Manual measurement _______________________________
Panel reading value ______________________________

c. Verify system stability by changing the controller set point as follows:

(1) Air temperature - 10 degrees F

(2) Water temperature - 10 degrees F

(3) Static pressure - 10 percent of set point

(4) Relative humidity - percent (RH)

The control system shall be observed for 10 minutes after the change in set point. Instability or excessive hunting will be unacceptable.

d. Verify interlock with other HVAC controls.

e. Verify interlock with fire alarm control panel.

f. Verify interlock with EMCS.

[g. Change controller set point 10 percent with EMCS and verify correct response.]

2. Verify that operation of control system conforms to that specified in the sequence of operation.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative _________________________

Contractor's Mechanical Representative ___________________________

Functional Performance Test Checklist - HVAC Controls

For HVAC System: [_____]

Contractor's Electrical Representative ______________________________

Contractor's Testing, Adjusting and Balancing Representative

____

Contractor's Controls Representative ______________________________

Contractor's Officer's Representative ______________________________

Using Agency's Representative ______________________________

Functional Performance Test Checklist - Energy Recovery System

For Energy Recovery System: [_____]

1. Functional Performance Test: Contractor shall demonstrate operation of energy recovery system as per specifications including the following: Start equipment to provide energy source for recovery system.

a. Verify energy source is providing recoverable energy. ____________

b. Verify recovery system senses available energy and activates. ____

c. Verify that recovery system deactivates when recoverable energy is no longer available. ____

2. Verify recovery system inlet/outlet readings, compare to design conditions and manufacturer's performance data.

	Design	Actual
Primary loop inlet temp (degrees F)	__________	__________
Primary loop outlet temp (degrees F)	__________	__________
Primary loop flow rate	__________	__________
Secondary loop inlet temp (degrees F)	__________	__________
Secondary loop outlet temp (degrees F)	__________	__________
Energy recovered BTU's)	__________	__________

3. Check and report unusual vibration, noise, etc.

____

____

4. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative__________________________

Contractor's Mechanical Representative __________________________

Contractor's Electrical Representative __________________________

Contractor's Testing , Adjusting and Balancing Representative

____

Contractor's Controls Representative __________________________

Contractor's Officer's Representative __________________________

Using Agency's Representative __________________________

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-16263 (April 1999)**
U.S. ARMY CORPS OF ENGINEERS | **-----------------------**
Superseding
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GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 1 (September 1999)

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SECTION 16263

DIESEL-GENERATOR SET STATIONARY 100-2500 KW, WITH AUXILIARIES
04/99

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NOTE: This guide specification covers requirements for stationary diesel-driven generator sets in the 100 to 2500 kilowatt capacity. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

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PART 1 GENERAL

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NOTE: This Specification is not for Procurement of Gas-fueled Engine-generator Sets.

Transient-load-response performance characteristics of natural gas, digester gas, propane, and liquefied petroleum gas engines differ significantly from those of diesel engines because of the fuel differences. Consult manufacturers for sample specifications.

Select the features and fill in blanks with values appropriate for the design condition. This specification does not apply to 400 Hz applications.

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1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS5	(1994; CS5a-1995) Cross-Linked Polyethylene Insulated Shielded Power Cables Rated 5 Through 46 kV
AEIC CS6	(1996) Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.11	(1987; R 1993) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)
ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 106	(1997a) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 181/A 181M	(1995b) Carbon Steel Forgings for General-Purpose Piping
ASTM A 234/A 234M	(1997) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperatures
ASTM B 395	(1995) U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes
ASTM B 395M	U-Beam Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes (Metric)

ASTM D 975	(1997) Diesel Fuel Oils

ASME INTERNATONAL (ASME)

ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B31.1	(1998) Power Piping
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

ELECTRICAL GENERATING SYSTEMS ASSOCIATION (EGSA)

EGSA 101P	(1995a) Engine Driven Generator Sets

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE C57.13	(1993) Instrument Transformers
IEEE ANSI/IEEE C57.13.1	(1981; R 1992) IEEE Guide for Field Testing of Relaying Current Transformers
IEEE Std 1	(1986; R 1992) General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation
IEEE Std 43	(1974; R 1991) Testing Insulation Resistance of Rotating Machinery
IEEE Std 48	(1998) Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
IEEE Std 100	(1996) IEEE Standard Dictionary of Electrical and Electronics Terms
IEEE Std 120	(1989) Electrical Measurements in Power Circuits
IEEE Std 115	(1995) Test Procedures for Synchronous

	Machines
IEEE Std 404	(1993; errata) Cable Joints for Use with Extruded Dielectric Cable Rated 5000 V Through 138 000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500 V Through 500 000 V
IEEE Std 484	(1996) Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications
IEEE Std 485	(1997) Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations
IEEE Std 519	(1992) Harmonic Control in Electrical Power systems

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures
NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3 Rev 4) Motors and Generators
NEMA PB 1	(1995) Panelboards
NEMA PB 2	(1995) Deadfront Distribution Switchboards
NEMA SG 5	(1995) Power Switchgear Assemblies
NEMA WC 7	(1991; Rev 1) Cross-Linked-thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 8	(1991; Rev 1; Rev 2) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and

Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(1996; Errata; TIA 96-2) Flammable and Combustible Liquids Code
NFPA 37	(1998) Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	(1999) National Electrical Code
NFPA 99	(1999) Health Care Facilities
NFPA 110	(1999) Emergency and Standby Power Systems

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J 537	(1996) Storage Batteries

UNDERWRITERS LABORATORIES (UL)

UL 891	(1994; Rev thru Jan 1995) Dead-Front Switchboards
UL 1236	(1994; Rev thru Dec 1997) Battery Chargers for Charging Engine-Starter Batteries

1.2 SYSTEM DESCRIPTION

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NOTE: Engine Generator Parameter Schedule. Where multiple engine-generator sets of different sizes or applications are to be provided, a Parameter Schedule should be shown on the contract drawings (one for each engine-generator set to be installed). If only one engine-generator set is provided (or multiples of the same type, size, etc.), the schedule may be in the body of the specification. Note that the specifications refer to the Engine Generator Parameter Schedule and the designer must provide one each by that name.

Some load applications require precise generator output frequency, voltage, level waveform characteristics and control of transient response. Most loads do not require stricter control than most off-the-shelf engine generator sets can provide. The criticality of the output and response characteristics can affect: selection of the governor type, whether it is to be isochronous or droop, and its steady state bandwidth; selection of the voltage regulator parameters; transient recovery time for frequency and voltage; maximum voltage and frequency deviation for a transient event; and because of the maximum deviations and transient recovery times, the sizing or oversizing of the

engine and generator. The notes below are included to assist the designer in making informed choices when filling in the Engine Generator Parameter Schedule.

Power Ratings and Industry Terminology. The following definitions are from the Electrical Generating Systems Association Standard 101P, Engine Driven Generating Sets. Stationary diesel-engine-driven electric generator sets are divided into the following four rating categories: EMERGENCY STANDBY, LIMITED RUNNING TIME, PRIME POWER, and INDUSTRIAL.

"EMERGENCY STANDBY RATING means the power that the generator set will deliver continuously under normal varying load factors for the duration of a power outage." It must be understood that this definition uses the term "normal varying load conditions". Most manufacturers use this terminology to indicate that their units typically are not rated for continuous operation at the nameplate rating, but rather that the units provided are rated for continuous operation at 70% to 80% of their nameplate rating, with periodic loading up to 100% of the nameplate rating for short (cyclical) periods during a power outage. When specifying a genset be sure to specify what the peak load is and how much is continuous

"LIMITED RUNNING TIME RATING means the power that the generator set will deliver when used as a utility type power source, typically in load curtailment type service, for a limited number of hours, where there are non-varying load factors and/or constant dedicated loads."

"PRIME POWER RATING means the power that the generator set will deliver when used as a utility type power plant under normal varying load factors to run continuously. This rating requires a minimum momentary overload capability of 10%."

"INDUSTRIAL RATING means the power that the generator set will deliver 24 hours per day when used as a utility type power plant where there are non-varying load factors and/or constant dedicated loads."

Overload Capacity. Overload capacity is only for PRIME rated units. Delete for standby applications.

Power Factor. Commercial genset power ratings are usually based on 0.8 power factor. Select 0.8

unless the application requires one more stringent.

Loading. When specifying engine-generator sets the designer will analyze the load characteristics and profiles of the load to be served to determine the peak demand, maximum step load increase and decrease, motor starting requirements represented as starting kVA, continuous and non-continuous (cyclical/periodic), and the non-linear loads to be served. This information should be included in the engine-generator set parameter schedule or on the drawings for each different unit provided. For this application, service load is the peak estimated loading (continuous plus non-continuous) to be placed on the engine generator set.

Peak demand calculation provides a figure from which to determine the service load. For prime applications the service load should include spare capacity for future load growth and spinning reserve (reserve generation beyond that required to satisfy immediate needs and/or system peak demands). Spare capacity for prime applications should be based on the facility master plan load projections.

Motor Starting Load. Motor starting requirements are important to properly size engine generator sets because the starting current for motors can be as much as six times the running current, and can cause generator output voltage and frequency to drop, even though the genset has been sized to carry the running load. The designer must analyze the motor loads to determine if the starting characteristics of a motor or a group of motors to be started simultaneously will cause objectionable genset performance. Provide a motor starting kVA value for the largest motor or combination of motors to be started simultaneously. An increase in the size rating of the genset may be necessary to compensate for the inrush current. This assists the genset supplier in properly sizing the engine generator set.

Maximum Speed. The maximum allowable speed is 1800 RPM. If there is not specific requirement or user requirement for slower speed machines, select 1800 RPM. Selection of the maximum 1800 RPM does not preclude provision of slower speed machines, for example, in the larger sizes (above 2000 kW), where 1800 RPM machines may not be available.

Heat Exchanger Type. Fin-tube heat exchangers (radiators) are the predominate method of cooling. Specify either a fin-tube or a shell-tube heat exchanger for each engine-generator set. Heat exchangers located remote from the engine-generator set (i.e.,. not mounted on the engine-generator set base) will be shown on the project plans, including the power source for associated fans and pumps.

Governor. The type of governor to be used on each engine generator set should be identified as isochronous or droop on the engine-generator set parameter schedule. Isochronous governors hold frequency at the setpoint frequency (within bandwidth) for all steady state loads from 0 to 100% load and are required for applications where severe demands are made on voltage and frequency regulation. Droop governors allow frequency to droop to the specified percentage proportional to steady state loads from 0 to 100% load and are generally acceptable for general purpose and commercial applications.

Engine-generator sets in stand alone service (isolated bus) may utilize either droop or isochronous governors. The designer should analyze the application and loads to determine if the more expensive isochronous unit is actually required. Droop units provide added stability (less engine cycling) in single unit applications where constant speeds are not critical and are less expensive than isochronous governors.

Engine-generator sets in parallel (on an isolated bus) may also utilize either droop or isochronous governors. Load swings are shared proportionally based on the governor droop settings. The load will be split equally among the units for all units equipped with isochronous governors with load sharing controls, or if all units have droop governors that are set with the same droop. "Lead units" are often designated in multiple unit applications for tighter frequency control by setting one governor at a much lower droop than the others. A "lead unit" can be designated for gensets equipped with isochronous governors if all units have governors with load sharing controls. In this case the "lead unit" will accept all load swings and the other units will remain at a constant load. When all units have droop governors, the "lead units" will accept most of the load swings and the other units will equally split a small portion of the load. If isochronous governors are specified for two or more units to be paralleled on an isolated bus, the governors must be specified with load sharing controls. For applications involving units in parallel operation which are not operator supervised the designer should specify a load-sharing system which can proportionally load two or more sets in parallel, each having isochronous governors. Generators for use with existing generators in parallel applications must have similar characteristics. Droop paralleling is specified for electrical and electro-hydraulic governors where interconnection of all controls is not possible such as when paralleling to a large electrical utility grid network. When paralleling two or more droop units with a utility grid (or with other droop units), to achieve load sharing, the unit governors must be compatible, their speed settings must be matched, and the droop must be set the same on all units. Droop adjustment range of 0 to 7% is typical for mechanical-hydraulic governors, and 0 to 10% is typical for electro-hydraulic governors. Isochronous units should not be paralleled with an infinite bus (utility grid system) without also specifying synchronizing and governor-load sharing controls. Delete speed droop adjustment for isochronous governors in non-parallel applications.

Frequency Bandwidth. Governor frequency bandwidth defines the allowable steady state variation in frequency as is typically quite small for commercially available governors (typically less than ± 0.4% with ± 0.25% readily available). The predominant type of device loads which are susceptible to steady state frequency deviations less than ± 0.4% are those which employ switching power supplies (computers and variable frequency drives). The designer should select the least restrictive value for bandwidth for the application.

Voltage Regulators. Solid state regulators are readily available which maintain the voltage level (regulation or voltage droop) to ± 2% from no load to full load, while some manufacturers offer regulators which limit the droop to ± 0.5%. Voltage regulator bandwidth is important relative primarily to transient response. EGSA Standard 100R-1992 defines three performance classes for voltage regulators: standard (2% bandwidth); high (1% bandwidth); and precision (0.5% bandwidth). Select the least restrictive bandwidth necessary to satisfy the application requirement.

Generator frequency and voltage should be shown on the engine-generator set schedule. (For example: 208Y/120 volts, 3-phase, 4-wire).

Subtransient Reactance. The subtransient reactance of a generator is the impedance characteristic which

determines current during the first cycle after a system short circuit condition is presented to the generator. Therefore, it is used to determine the necessary interrupting capacity of the genset circuit interrupting device. It also is utilized to predict generator response to non-linear loads. Typical values for generator subtransient reactance are found in IEEE Std 141. Subtransient reactance is specified in per unit of the generator rated kVA. Also, see the following discussion on non-linear loads.

Non-linear Loads: Non-linear loads are addressed in IEEE Std 519. They are loads that draw a non-sinusoidal current waveform when supplied by a sinusoidal voltage source. Typical non-linear loads include solid state switching power supplies, computer power supplies (including those found in desktop PC's, uninterruptible power supplies, variable frequency drives, radar power supplies, and solid state ballasts in fluorescent light fixtures. They cause distortion of the source voltage and current waveforms that can have harmful effects on many types of electrical equipment and electronics, including generators. Non-linear loads are similar to short circuits in that they provide momentary, sub-cycle-duration, short-circuiting of two phases. Switching power supplies consist of SCR/thyristor-controlled rectifier bridges which act as three single-phase loads, each connected across two phases of the power system. When the SCR/thyristors are switched on and off a notch in the voltage waveform will occur as a result of an instantaneous phase-phase short-circuit during the commutation of current. A low generator subtransient reactance minimizes the voltage waveform distortion in the presence of such loads. For this reason when the non-linear loads comprise 25% or more of the loads served, the generator subtransient reactance should be limited to no more than 0.12.

Delete Subtransient Reactance from the Engine-Generator Parameter Schedule where the genset manufacturer is responsible for sizing the generator breaker and where the non-linear loads served are less than 25%.

Generators are particularly vulnerable to control problems and instability, excessive winding heating, neutral overheating, reduced efficiency, reduced torque, shaft fatigue, accelerated aging, and induced mechanical oscillations when non-linear loads are applied without careful consideration of

the generator's capability to supply them. Measures which can be used to mitigate the effects of non-linear loads on generators include: procurement of low impedance generators with special windings to compensate for the additional heating; installation of harmonic filter traps; avoidance of self-excited generators; use of 2/3 pitch factor (rather than 5/6 pitch) generator windings; and generator derating with oversized neutrals.

For large non-linear loads, filter traps which are tuned to the dominant harmonic frequencies of the non-linear loads should be procured/provided with the load component. This approach is normally less costly than procurement of specially designed or derated generators.

For combinations of linear and non-linear loads where the percentage of non-linear loads is small relative to the capacity rating of the generator (25% or less), standard generator configurations are normally acceptable.

Provide a list of the non-linear loads in the parameter schedule, either on the drawings (and denoted on the single-line diagram) or in tabular form in the specification section. The list should contain a description of the load including equipment type, whether the rectifier is 6-pulse or 12-pulse, kVA rating, and frequency. Provide a linear load value (kVA @ PF) which represents the maximum linear load demand when non-linear loads will also be in use. The generator manufacturer will be required to meet the total harmonic distortion limits established in IEEE Std 519. Delete the non-linear load paragraph when non-linear loads are not served from the engine-generator set.

Maximum Step Load Increase. Maximum step load increase is used to account for the addition of block loads. These affect engine-generator set frequency and voltage output and usually initiate governor and regulator response. The change in engine-generator set output and the response of the governor and regulator defines the transient loading response. The designer should provide the actual loads to be applied to the engine-generator set because specification of maximum step load increases of 75 or 100% requires significant oversizing of engines and generators and/or addition of mass to fly-wheel, all of which add cost. Additionally, oversizing of engines causes maintenance problems and increases operating costs. The following percentages may be used when the actual load acquisition rate cannot be determined. A maximum step load increase of 25% should be used for prime rated sets, 50% for optional standby rated sets with step loading, and 100% for legally required standby (emergency) service with no step loading.

Transient Response Criteria (short time duration). Genset-set response and recovery times vary according to the size of the set, the block load, and the controls specified. Normal response to addition of a block load will include dips in either output voltage or frequency or both and possible "overshoot" as the governor and voltage regulator respond to bring the voltage and frequency back within bandwidth. Normal response to loss of a block load will include an upward spike in output voltage or frequency back within bandwidth. The Maximum Voltage and Frequency Deviation apply to undervoltage/underfrequency ("dips") from the addition of block loads and any undershoot resulting from the recovery of an upward spike, as well as overvoltage/overfrequency (upward spikes) from the loss of block loads and any overshoot resulting from the recovery of a dip.

Cost Impact. If stringent transient-response requirements are specified, the manufacturer may select engine and generator models which have nominal rating much larger than the service load; may use an unnecessarily expensive governor; and may use a higher inertia flywheel. The designer should investigate what may actually be provided so that the cost estimate will be reasonably accurate and to confirm the selected transient requirements are not unnecessarily stringent. A maximum size for the engine-generator set may be needed to avoid the problems associated with a small load on a large capacity set.

The designer must determine the cost benefits of providing an uninterruptible power system for transient ride-through versus purchasing a generator with stringent transient response requirements. In determining the allowable voltage and frequency variation and recovery times, analyze the effects on equipment performance and recovery. Consult the NEMA utilization equipment standards to determine the maximum allowable voltage dips/overshoots (excursions).

Maximum Voltage Deviation. Select the 5% Maximum Voltage Deviation option only if communication equipment or other sensitive electronic equipment are a critical part of the load, and there is no UPS provided. Fluorescent lights can tolerate a maximum of 10% voltage variation. NEMA induction motors and control relays can tolerate a maximum of 10% variation, for 30 cycles and one cycle respectively. Solenoids (brakes, valves, clutches) and ac & dc starter coils can tolerate a maximum of minus 30% variation, for 1/2 cycle, 2 cycles (dropout), and 5 - 10 cycles (dropout) respectively. (The times listed in cycles are not given to define the recovery time back to bandwidth, but to assist the designer in defining the maximum allowable voltage deviation.) The designer should realistically asses the need for limiting the transient voltage dip to less than 30%.

Maximum Frequency Deviation. Computers can usually tolerate only ± 0.5 Hz variation, so an UPS is normally required where computer services should not be interrupted, or where system recovery times are critical. Inverters can tolerate ± 2 Hz variation. NEMA induction motors and control relays can tolerate a maximum of 5% frequency variation. (The times listed in cycles are not given to define the recovery time back to bandwidth, but to assist the designer in defining the maximum allowable frequency deviation.) The designer must be realistic in assessing the needs of the facility to be served so that unnecessarily stringent requirements are not specified.

Recovery Time Back to Bandwidth. The designer should determine the required recovery time for the loads served. The recovery time to bandwidth is not critical to operation of most equipment if the voltage and frequency do not deviate from the critical limits, or if momentary interruption is acceptable to the loads being served. The primary importance of this requirement is to ensure that the engine generator set recovers and stabilizes after load changes. Most engine generator sets can respond to 100% block loads and return to voltage and frequency bandwidths within 15 - 20 seconds, depending on the size of the machine (RPM, relative mass of the rotating elements, and ambient conditions).

Maximum Step Load Decrease (without shutdown). An engine generator set should be capable of being unloaded in a single step without tripping offline. In these situations the voltage and frequency transients are of no concern because there is no load being served.

Nominal Step Load Decrease. Step load decrease is

used to account for dropping of block loads. This affects engine-generator set frequency and voltage output and usually initiates governor and regulator response. The change in engine-generator set output and the response of the governor and regulator defines the transient loading response. Where the load served may be sensitive to voltage and frequency variation due to significant load decrease, include the items below in the Parameter Schedule. The Nominal Step Load Decrease provides the genset manufacturer with the information necessary to set the governor response for load decreases such than an overspeed (over-frequency) condition does not occur. The cost of engine-generator sets increase by large percentages for smaller frequency and voltage deviations from bandwidth and improved recover times. Carefully analyze the user's need for restrictions on frequency, voltage, and waveform characteristics.

Nominal Step Load Decrease	**[25] [50] [75] percent of Service Load at [_____] PF**
Transient Recovery Time with Step Load Decrease (Voltage)	**[_____] seconds**
Transient Recovery Time with Step Load Decrease (Frequency)	**[_____] seconds**
Maximum Voltage Deviation with Step Load Decrease	**[5] [10] [30] [_____] percent of rated voltage**
Maximum Frequency Deviation with Step Load Decrease	**[2.5] [5] [_____] percent of rated frequency**

Maximum Time To Start and Assume Load. Choose 10 seconds for emergency-standby applications (critical for life safety). NFPA 70 requires that standby engine-generator sets used in emergency applications start and assume load in 10 seconds. Most commercially available engine generator sets are capable of starting and assuming load within 10 seconds, however, a default value of 20 second is non-restrictive and provides a reasonable maximum value for non-critical applications.

Temperature Management. The designer is responsible for temperature control in the space occupied by the engine generator set. However, because the genset supplier normally provides the engine cooling system (and block heaters where required), the designer must provide ambient conditions under which the engine generator must operate, so that the supplier can size the equipment. Typically, high temperature provides the most restrictive condition, therefore the designer must design air-flow of adequate temperature and sufficient quantity to maintain the temperature of the generator and engine space within acceptable limits. This requires the designer to consult manufacturers literature and/or representatives to determine the nominal heat rejection to the surroundings at rated genset capacity (from all heat sources) to determine the required cooling or air flow through the engine generator set room or enclosure. In turn the manufacturer must submit the specific operating data in order for the contracting officer/designer to verify that the proposed equipment meets the design parameters.
****

Each engine-generator set shall be provided and installed complete and totally functional, with all necessary ancillary equipment to include: air filtration; starting system; generator controls, protection, and isolation; instrumentation; lubrication; fuel system; cooling system; and engine exhaust system. Each engine-generator set shall satisfy the requirements specified in the Engine-Generator Parameter Schedule.

1.2.1 Engine-Generator Parameter Schedule

ENGINE-GENERATOR PARAMETER SCHEDULE

Power Rating	[Prime] [Limited Running Time] [Emergency Standby] [Industrial]
Overload Capacity (Prime applications only)	110% of Service Load for 1 hour in 12 consecutive hours
Service Load	[_____] kVA (maximum) [_____] kVA (continuous
Motor Starting kVA (Max.)	[_____] kVA
Power Factor	[0.8] [_____] lagging
Engine-Generator Applications	[stand-alone] [parallel with infinite bus] [parallel with other generators on an isolated bus] [parallel with other generators on an infinite bus]
Maximum Speed	[_____] [900] [1200] [1800] rpm

ENGINE-GENERATOR PARAMETER SCHEDULE

Heat Exchanger Type	[fin-tube (radiator)] [shell-tube]
[Governor Type	Isochronous
Frequency Bandwidth (steady state)]	± [_____] [0.4] [0.25] %
[Governor Type	Droop
Frequency Regulation (droop) (No Load to Full Load)	[3] [_____] % (maximum)
Frequency Bandwidth (steady state)]	± [_____] [0.4] [0.25] %
Voltage Regulation (No Load to Full Load) (Stand alone applications)	± 2% (maximum)
Voltage Bandwidth (steady state)	± [0.5] [1] [2] %
Frequency	[50] [60] Hz
Voltage	[_____] volts
Phases	[3 Phase, Wye] [3 Phase, Delta]
Minimum Generator Subtransient Reactance	[_____] %
Nonlinear Loads	[_____] kVA
Max Step Load Increase	[25] [50] [75] [100] % of Service Load at [_____] PF
Transient Recovery Time with Step Load Increase (Voltage)	[_____] seconds
Transient Recovery Time with Step Load Increase (Frequency)	[_____] seconds
Maximum Voltage Deviation with Step Load Increase	[5] [10] [30] [_____] % of rated voltage
Maximum Frequency Deviation with Step Load Increase	[2.5] [5] [_____] % of rated frequency
Max Step Load Decrease (without shutdown)	100 % of Service Load at [_____] PF
Max Time to Start and be Ready to Assume Load	[10] [_____] seconds
Max Summer Indoor Temp	[_____] degrees

ENGINE-GENERATOR PARAMETER SCHEDULE
(Prior to Genset Operation)

Min Winter Indoor Temp (Prior to Genset Operation)	[_____] degrees
Max Allowable Heat Transferred To Engine Generator Space at Rated Output Capacity	[_____] MBTU/hr
Max Summer Outdoor Temp (Ambient)	[_____] degrees
Min Winter Outdoor Temp (Ambient)	[_____] degrees
Installation Elevation	[_____] above sea level

1.2.2   Rated Output Capacity

****

NOTE: The service load for each genset should be shown on the Engine-Generator Parameter Schedule. The designer must determine the service load. The Contractor, through the supplier's manufacturer/assembler, determines the efficiency and associated ancillary equipment loads. The designer must examine spare capacity requirements for spinning reserve.

****

Each engine-generator-set shall provide power equal to the sum of Service Load plus the machine's efficiency loss and associated ancillary equipment loads. Rated output capacity shall also consider engine and/or generator oversizing required to meet requirements in paragraph Engine-Generator Parameter Schedule.

1.2.3   Power Ratings

Power ratings shall be in accordance with EGSA 101P.

1.2.4   Transient Response

The engine-generator set governor and voltage regulator shall cause the engine-generator set to respond to the maximum step load changes such that output voltage and frequency recover to and stabilize within the operational bandwidth within the transient recovery time. The engine-generator set shall respond to maximum step load changes such that the maximum voltage and frequency deviations from bandwidth are not exceeded.

1.2.5   Reliability and Durability

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NOTE: Mean time between overhauls describes the

average number of operating hours that the engine will operate satisfactorily without overhaul. Overhaul is a natural consequence of the engine in operation due to worn out parts after the indicated operating hours.

****

[Each prime engine-generator set shall have both an engine and a generator capable of delivering the specified power on a prime basis with an anticipated mean time between overhauls of not less than 10,000 hours operating with a 70% load factor. Two like engines and two like generators shall be cited that have performed satisfactorily in a stationary power plant, independent from the physical location of the manufacturer's and assembler's facilities. The engine and generators should have been in operation for a minimum of 8000 actual hours at a minimum load of 70% of the rated output capacity. During two consecutive years of service, the units should not have experienced any failure resulting in a downtime in excess of 72 hours. Like engines shall be of the same model, speed, bore, stroke, number and configuration of cylinders and rated output capacity. Like generators shall be of the same model, speed, pitch, cooling, exciter, voltage regulator and rated output capacity.] [Each standby engine-generator set shall have both an engine and a generator capable of delivering the specified power on a standby basis with an anticipated mean time between overhauls of no less than 5,000 hours operating with a load factor of 70%. Two like engines and two like generators shall be cited that have performed satisfactorily in a stationary power plant, independent and separate from the physical location of the manufacturer's and assembler's facilities, for standby without any failure to start, including all periodic exercise. Each like engine and generator shall have had no failures resulting in downtime for repairs in excess of 72 hours during two consecutive years of service. Like engines shall be of the same model, speed, bore, stroke, number and configuration of cylinders, and rated output capacity. Like generators shall be of the same model, speed, pitch, cooling, exciter, voltage regulator and rated output capacity.]

1.3 GENERAL REQUIREMENTS

1.3.1 Engine-Generator Set

Each set shall consist of one engine, one generator, and one exciter mounted, assembled, and aligned on one base; and other necessary ancillary equipment which may be mounted separately. Sets having a capacity of 750 kW or smaller shall be assembled and attached to the base prior to shipping. Sets over 750 kW capacity may be shipped in sections. Each set component shall be environmentally suitable for the location shown and shall be the manufacturer's standard product offered in catalogs for commercial or industrial use. Any nonstandard products or components and the reason for their use shall be specifically identified in paragraph SUBMITTALS.

1.3.2 Nameplates

****

NOTE: Delete any equipment not applicable to the project.

****

Each major component of this specification shall have the manufacturer's name, type or style, model or serial number and rating on a plate secured to the equipment. As a minimum, nameplates shall be provided for:

Engines	Relays
Generators	Transformers (CT & PT)
Regulators	Day tanks
Pumps and pump motors	Governors
Generator Breaker	Air Starting System
Economizers	Heat exchangers (other than base mounted)

Where the following equipment is not provided as a standard component by the diesel engine generator set manufacturer, the nameplate information may be provided in the maintenance manual in lieu of nameplates.

Battery charger	Heaters
Switchboards	Exhaust mufflers
Switchgear	Silencers
Battery	Exciters

1.3.3 Personnel Safety Devices

Exposed moving parts, parts that produce high operating temperatures, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. The safety devices shall be installed so that proper operation of the equipment is not impaired.

1.3.4 Verification of Dimensions

Before performing any work, the premises shall be visited and all details of the work verified. The Contracting Officer shall be advised in writing of any discrepancies.

1.3.5 Conformance to Codes and Standards

Where equipment is specified to conform to requirements of any code or standard such as UL, NEMA, etc., the design, fabrication and installation shall also conform to the code.

1.3.6 Site Welding

Structural members shall be welded in accordance with Section 05090 WELDING, STRUCTURAL. For all other welding, procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1. Welder qualification tests shall be performed for each welder whose qualifications are not in compliance with the referenced standards. The Contracting Officer shall be notified 24 hours in advance of qualification tests. The qualification tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

1.3.7 Parallel Operation

****

NOTE: Specification of an engine-generator set capable of parallel operation with a utility

requires a 2/3 pitch generator winding and special coordination of protective devices with the utility system protection scheme. Do not specify this option without also providing a design for the protective device coordination which has been approved by the utility involved.
****

Each engine-generator set specified for parallel operation shall be configured for [automatic] [manual] parallel operation. Each set shall be capable of parallel operation with [a commercial power source on an infinite bus] [one or more sets on an isolated bus] [a commercial power source on an infinite bus and with one or more sets on an isolated bus].

1.3.8 Load Sharing

****
NOTE: Coordinate with paragraph Engine Generator parameter Schedule.
****

Each engine-generator set specified for parallel operation shall be configured to [manually load share with other sets.] [automatically load share with other sets by proportional loading. Proportional loading shall load each set to within 5% of its fair share. A set's fair share is its nameplate-rated capacity times the total load, divided by the sum of all nameplate-rated capacities of on-line sets. Load sharing shall incorporate both the real and reactive components of the load.]

1.3.9 Engine-Generator Set Enclosure

****
NOTE: If the engine-generator set is to be installed outdoors include requirements for the weatherproof enclosure in the engine-generator set schedule. Define corrosion resistance and/or material required for the environment. Provide structural loading required for the geographic area (wind loads, snow loads, etc.). A generator set enclosure may also be needed to mitigate excessive noise caused by the engine generator set mechanical components. Delete the reference to mechanical noise limitations if an enclosure is not needed to mitigate sound emissions. If a sound enclosure is not provided, the designer must provide a design to prevent excessive noise (meet OSHA requirements). Delete this paragraph if no engine-generator set enclosure is needed.
****

The engine-generator set enclosure shall be corrosion resistant and fully weather resistant. The enclosure shall contain all set components and provide ventilation to permit operation at Service Load under secured conditions. Doors shall be provided for access to controls and equipment requiring periodic maintenance or adjustment. Removable panels shall be provided for access to components requiring periodic replacement. The enclosure shall be capable of being removed without disassembly of the engine-generator set or removal of components other than the exhaust system. The enclosure shall reduce the noise of the generator set to within the limits specified in the paragraph SOUND LIMITATIONS.

1.3.10 Vibration Limitation

The maximum engine-generator set vibration in the horizontal, vertical, and axial directions shall be limited to 6 mils (peak-peak RMS), with an overall velocity limit of 0.95 inches/second RMS, for all speeds through 110% of rated speed.

1.3.11 Vibration Isolation

****

NOTE: See TM 5-805-9, Power Plant Acoustics, and TM 5-805-4, Noise and Vibration Control For Mechanical Equipment for vibration criteria. Vibration isolation systems should be applied where vibration transmitted through the genset support structure produces (either directly or by resonant frequencies of structural members) annoying or damaging vibration in the surrounding environment. Select the manufacturer's standard or provide the maximum allowable vibration force where necessary to limit the maximum vibration. Delete the vibration isolation requirement for applications where vibration does not affect the floor or foundation.

****

[A vibration-isolation system shall be installed between the floor and the base. The vibration-isolation system shall limit the maximum vibration transmitted to the floor at all frequencies to a maximum of [_____] (peak force).] [The engine-generator set shall be provided with a vibration-isolation system in accordance with the manufacturer's standard recommendation.] Vibration-isolation systems shall be designed and qualified (as an integral part of the base and mounting system in accordance with the seismic parameters specified. Where the vibration-isolation system does not secure the base to the structure floor or unit foundation, seismic restraints shall be provided in accordance with the seismic parameters specified.

****

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01/93

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SECTION 16370

ELECTRICAL DISTRIBUTION SYSTEM, AERIAL
01/93

****

NOTE: This guide specification covers the requirements for aerial electrical distribution systems using wood, steel, aluminum, and concrete poles. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for medium voltage lines, low voltage lines, wood poles, steel poles, and concrete poles. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C29.1	(1988; R 1996) Electrical Power Insulators - Test Methods
ANSI C29.2	(1992) Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type
ANSI C29.3	(1986; R 1995) Wet Process Porcelain Insulators - Spool Type
ANSI C29.4	(1989; R 1995) Wet-Process Porcelain Insulators - Strain Type
ANSI C29.5	(1984; R 1995) Wet-Process Porcelain Insulators - Low- and Medium-Voltage Types
ANSI C29.6	(1996) Wet-Process Porcelain Insulators - High-Voltage Pin Type
ANSI C29.8	(1985; R 1995) Wet-Process Porcelain Insulators - Apparatus, Cap and Pin Type
ANSI C29.9	(1983; R 1996) Wet-Process Porcelain Insulators - Apparatus, Post-Type
ANSI C37.32	(1996) High-Voltage Air Switches, Bus Supports, and Switch Accessories - Schedules of Preferred Ratings, Manufacturing Specifications, and Application Guide
ANSI C57.12.20	(1994) Transformers, Overhead-Type Distribution Transformers, 500 kVA and Smaller: High Voltage, 34 500 Volts and Below; Low Voltage, 7970/13 800Y Volts and Below
ANSI C135.1	(1979) Galvanized Steel Bolts and Nuts for Overhead Line Construction
ANSI C135.2	(1987) Threaded Zinc-Coated Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction
ANSI C135.4	(1987) Zinc-Coated Ferrous Eyebolts and Nuts for Overhead Line Construction

ANSI C135.14	(1979) Staples with Rolled or Slash Points for Overhead Line Construction
ANSI C135.22	(1988) Zinc-Coated Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction
ANSI C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction
ANSI O5.1	(1992) Specifications and Dimensions for Wood Poles

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1996) Carbon Structural Steel
ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 475	(1998) Zinc-Coated Steel Wire Strand
ASTM A 575	(1996) Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 576	(1990b; R 1995) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B 1	(1995) Hard-Drawn Copper Wire
ASTM B 8	(1995) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM B 228	(1993) Concentric-Lay-Stranded Copper-Clad Steel Conductors
ASTM B 230	(1997) Aluminum 1350-H19 Wire for Electrical Purposes
ASTM B 231	(1995) Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B 232	(1997) Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)
ASTM B 398	(1997) Aluminum-Alloy 6201-T81 Wire for Electrical Purposes
ASTM B 399	(1997) Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors
ASTM B 416	(1993) Concentric-Lay-Stranded Aluminum-Clad Steel Conductors

ASTM D 923	(1997) Sampling Electrical Insulating Liquids
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 4059	(1996) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography.
ASTM F 883	(1997) Padlocks

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C4	(1995) Poles - Preservative Treatment by Pressure Processes
AWPA C25	(1995) Sawn Crossarms - Preservative Treatment by Pressure Processes
AWPA P1/P13	(1995) Standard for Coal Tar Creosote for Land and Fresh Water and Marine (Coastal Water Use)
AWPA P5	(1997) Standards for Waterborne Preservatives
AWPA P8	(1997) Standards for Oil-Borne Preservatives
AWPA P9	(1997) Standards for Solvents for Organic Preservative Systems

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE C37.34	(1994) Test Code for High-Voltage Air Switches
IEEE C37.41	(1994; C37.41e) Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories
IEEE C37.60	(1981; R 1992) Requirements for Overhead, Pad Mounted, Dry Vault and Submersible Automatic Circuit Reclosers and Fault Interrupters for AC Systems
IEEE C37.63	(1997) Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizer for AC Systems
IEEE C57.12.00	(1993) IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

IEEE C57.13.2	(1991) IEEE Standard Conformance Test Procedures for Instrument Transformers
IEEE C57.15	(1986; R 1992) Requirements, Terminology, and Test Code for Step-Voltage and Induction-Voltage Regulators
IEEE C57.19	(1991; R 1997) IEEE Standard General Requirements and Test Procedures for Outdoor Power Apparatus Bushings
IEEE C57.19.01	(1991; R 1997) IEEE Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings
IEEE C57.98	(1993) Guide for Transformer Impulse Tests
IEEE C62.1	(1989; R 1994) Surge Arresters for AC Power Circuits
IEEE C62.2	(1987; R 1994) Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems
IEEE C62.11	(1998) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
IEEE Std 18	(1992) Shunt Power Capacitors
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
IEEE Std 100	(1996) IEEE Standard Dictionary of Electrical and Electronics Terms
IEEE Std 242	(1986; R 1991) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
IEEE Std 399	(1997) Recommended Practice for Industrial and Commercial Power Systems Analysis
IEEE Std 404	(1993; errata) Cable Joints for Use with Extruded Dielectric Cable Rated 5000 V Through 138 000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500 V Through 500 000 V

INSULATED CABLE ENGINEERING ASSOCIATION (ICEA)

ICEA S-70-547	(1992) Weather Resistant Polyolefin Covered Wire & Cable

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA HV 2	(1991) Application Guide for Ceramic Suspension Insulators

NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures
NEMA LA 1	(1992) Surge Arresters
NEMA SG 2	(1993) High Voltage Fuses
NEMA WC 5	(1992; Rev 1) Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 7	(1991; Rev 1) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 8	(1991; Rev 1; Rev 2) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

RURAL UTILITIES SERVICES (RUS)

RUS Bull 1728H-701	(1993) Specification for Wood Crossarms (Solid and Laminated), Transmission Timbers and Pole Keys

UNDERWRITERS LABORATORIES (UL)

UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 486A	(1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1997; Rev Jun 1997) Wire Connectors for Use with Aluminum Conductors

1.2 GENERAL REQUIREMENTS

****
NOTE: Select the features and fill in blanks with selections appropriate for the design condition and in accordance with guidance contained in TM 5-811-1.
****

1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.

1.2.2 Service Conditions

****
NOTE: See TM 5-811-1 for guidance regarding service conditions. Retain or add the required conditions.

Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record and show on the drawings. Delete the bracketed phrase if seismic details are not included. Sections 13080, 15070 and 16070, properly edited, must be included in the contract documents.
****

Items provided under this section shall be specifically suitable for the following service conditions. Seismic details shall conform to Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT, 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT, and 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT [as indicated].

a. Fungus Control [_____]

b. Altitude [_____]

c. Ambient Temperature [_____]

d. Frequency [_____]

e. Seismic Parameters [_____]

f. Corrosive Areas [_____]

g. [_____]

1.3 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

The number of copies of Operation and Maintenance Manuals, SD-19 will be the same as the quantity stated in the SPECIAL CONTRACT REQUIREMENTS. If none is specified, six copies will be required. Three additional copies will be submitted following approval, and will be provided to the Using Agency.

Delete SD-09 Reports, if local supplemental clauses duplicates this requirement.
****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Fault Current and Protective Device Coordination Study; [_____].

The study shall be submitted along with protective device equipment submittals. No time extensions or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed shall be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device settings, ratings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Manufacturer's Catalog; [_____].

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists; [_____].

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include the item number, the quantity of items proposed, and the name of the manufacturer of the item.

Installation Procedures; [_____].

As a minimum, installation procedures for regulators, transformers and reclosers. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

SD-04 Drawings

Electrical Distribution System; [_____].

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings. Detail drawings shall as a minimum include:

a. Constant current regulators.

b. Poles.

c. Calculations for steel poles and power installed screw foundations.

d. Crossarms.

e. Transformers.

f. Automatic circuit reclosers.

g. Pole top switches.

h. Conductors.

i. Insulators.

j. Surge arresters.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded.

b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

As-Built Drawings; [_____].

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

SD-09 Reports

Factory Test; [_____].

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests specified in applicable publications or in these specifications.

Field Testing; [_____].

A proposed field test plan [20] [30] [_____] days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Test Reports; GA.

[Six] [_____] copies of the information described below in 8-1/2 by 11 inch binders having a minimum of 5 rings, and including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The condition specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

SD-13 Certificates

Materials and Equipment; [_____].

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided under this section of the specifications conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform thereto. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms thereto. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms thereto. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies.

SD-19 OPERATION AND MAINTENANCE MANUALS

Electrical Distribution System; [_____].

[Six] [_____] copies of Operation and Maintenance manuals electrical distribution system shall be provided, within [7] [_____] calendar days following the completion of tests and shall include assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare-parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers. Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

Three additional copies of the instructions manual within 30 calendar days following the approval of the manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers and switches shall be stored in accordance with the manufacturer's requirements. Wood poles held in storage for more than 2 weeks shall be stored in accordance with ANSI O5.1. Handling of wood poles shall be in accordance with ANSI O5.1, except that pointed tools capable of producing indentations more than inch in depth shall not be used. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

1.5 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the Contracting Officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

Products shall conform to the following requirements. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.2 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.3 NAMEPLATES

2.3.1 General

Each major component shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Equipment containing liquid-dielectrics shall have the type of dielectric on the nameplate. Nameplates shall be made of noncorrosive metal. As a minimum, nameplates shall be provided for transformers, regulators, circuit breakers, capacitors, meters and switches.

2.3.2 Liquid-Filled Transformer Nameplates

****

NOTE: Coordinate Nameplate C information with the manufacturer. Select 50 ppm for Army projects and 2 ppm for Air Force projects.

****

Power transformers shall be provided in accordance with IEEE C57.12.00. Nameplates shall indicate the number of gallons and composition of liquid-dielectric, and shall be permanently marked with a statement that the transformer dielectric to be supplied is non-polychlorinated biphenyl. If transformer nameplate is not so marked, the Contractor shall furnish manufacturer's certification for each transformer that the dielectric in non-PCB classified, with less than [50] [2] ppm PCb content in accordance with paragraph LIQUID DIELECTRICS. Certifications shall be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the [50] [2] ppm PCB content or transformers without certification will be considered as PCB insulated and will not be accepted.

2.4 CORROSION PROTECTION

2.4.1 Aluminum Materials

[Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B shall be used.] [Aluminum shall not be used.]

2.4.2 Ferrous Metal Materials

2.4.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

2.4.2.2 Equipment

****

NOTE: A 120-hour test will be specified in a

noncorrosive environment and a 480-hour test will be specified in a corrosive environment.
****

Equipment and component items, including but not limited to transformers and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand [120] [480] hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The described test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

2.4.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section 09900 PAINTING, GENERAL.

2.5 CONDUCTORS, CONNECTORS, AND SPLICES

****
NOTE: Justify the selection of copper or aluminum, based upon an analysis using life, environmental, and cost factors.
****

2.5.1 Aluminum-Composition Conductors

[All-aluminum-conductors, AAC, shall be alloy 1350-H19 and comply with ASTM B 230 and ASTM B 231.] [All-aluminum-alloy-conductors, AAAC, shall be alloy 6201-T81 and comply with ASTM B 398 and ASTM B 399.] [Aluminum-conductor-steel-reinforced, ACSR, shall comply with ASTM B 232.]

2.5.2 Copper Conductors

Hard-drawn-copper conductors shall comply with ASTM B 1 and ASTM B 8 as appropriate for the conductor size.

2.5.3 Connectors and Splices

Connectors and splices shall be of copper alloys for copper conductors, aluminum alloys for aluminum-composition conductors, and a type designed to minimize galvanic corrosion for copper to aluminum-composition conductors. Aluminum-composition and aluminum-composition to copper shall comply with UL 486B, and copper-to-copper shall comply with UL 486A.

2.6 MEDIUM-VOLTAGE LINES

2.6.1 Bare Medium-Voltage Lines

Bare medium-voltage line conductors shall be [all-aluminum-conductor, AAC;] [all-aluminum-alloy-conductor, AAAC;] [aluminum-conductor-steel-reinforced, ACSR;] [hard-drawn-copper, CU]. Conductor types shall not be mixed on any project, unless specifically indicated. Conductors larger than No. 2 AWG shall be stranded.

2.6.2 Insulated Medium-Voltage Lines

****
NOTE: Select XLP for short life configuration. Select EPR for long life configuration. See TM 5-811-1 for guidance.
****

Insulated medium-voltage line conductors shall be of the factory-assembled, messenger-supported type, having a rated circuit voltage of [5] [15] [25] [_____] kV, and a 133 percent insulation level. Conductor material shall be [_____]. Insulation shall be [cross-linked thermosetting polyethylene (XLP) conforming to NEMA WC 7] [ethylene-propylene-rubber (EPR) conforming to NEMA WC 8] [_____]. Messengers shall be zinc-coated steel, aluminum-clad-steel, copper-clad-steel, or composite-copper and copper-clad steel.

2.7 LOW-VOLTAGE LINES

****
NOTE: Due to both space requirements and the unattractive appearance, line conductors on secondary racks will be limited to special circumstances.
****

Low-voltage line conductors shall be of the neutral-supported secondary and service drop type with [thermoplastic insulation in accordance with NEMA WC 5] [cross-linked thermosetting polyethylene (XLP) insulation in accordance with NEMA WC 7] [weather-resistant polyolefin-covered type conforming to ICEA S-70-547]. Neutral-supported secondary and service drop conductors shall be [insulated copper with bare hard-drawn-copper or copper-clad steel neutrals] [insulated aluminum with bare 1350 alloy aluminum or ACSR neutrals]. Conductors on secondary racks may be provided in lieu of neutral-supported cable for pole line circuits where necessary clearances are available.

2.8 POLES AND HARDWARE

****
NOTE: Use "class" for wood poles and "strength" for concrete and steel poles. Follow local utility practice regarding grounding metallic items on poles, after coordination with local DPW/BCE. Specify clearances and climbing space in accordance with IEEE C2 or applicable state code.
****

Poles shall be of lengths and [classes] [strengths] indicated.

2.8.1 Wood Poles

****
NOTE: Waterborne preservatives should not be used in humid and/or termite infested areas.

****

Wood poles shall comply with ANSI O5.1, and shall be pressure treated in accordance with AWPA C4, with creosote conforming to AWPA P1/P13or with oil-borne preservatives and petroleum conforming to AWPA P8 and AWPA P9, respectively, and waterborne preservatives conforming to AWPA P5. Waterborne preservatives shall be either chromated or ammoniacal copper arsenate. Any species listed in ANSI O5.1 for which a preservative treatment is not specified in AWPA C4, shall not be used; northern white cedar, if treated as specified for western red cedar, and western fir, if treated as specified for Douglas fir, may be used. Wood poles shall have pole markings located approximately 10 feet from pole butts for poles 50 feet or less in length, and 14 feet from the pole butts for poles longer than 55 feet in length. Poles shall be machine trimmed by turning smooth full length, and shall be roofed, gained, and bored prior to pressure treatment. Where poles are not provided with factory-cut gains, metal gain plates shall be provided.

2.8.2 Steel Poles

Steel poles shall be designed to withstand the loads specified in IEEE C2 multiplied by the appropriate overload capacity factors, shall be hot-dip galvanized in accordance with ASTM A 123/A 123M and shall not be painted. Poles shall have tapered tubular members, either round in cross-section or polygonal, and comply with strength calculations performed by a registered professional engineer. Calculations shall be submitted in accordance with the detail drawings portion of paragraph SUBMITTALS. Pole shafts shall be one piece. Poles shall be welded construction with no bolts, rivets, or other means of fastening except as specifically approved. Pole markings shall be approximately 3 to 4 feet above grade and shall include manufacturer, year of manufacture, top and bottom diameters, length, and a loading tree. Attachment requirements shall be provided as indicated, including grounding provisions. Climbing facilities are not required. Bases shall be of the anchor-bolt-mounted type.

2.8.3 Concrete Poles

****

NOTE: In areas where freezing temperatures occur, the minimum compressive strength given for concrete in spun poles should be increased in line with concrete design for such temperatures.

****

Concrete poles shall be designed to withstand the loads specified in IEEE C2 multiplied by the appropriate overload capacity factors. Poles shall be reinforced or prestressed, either cast or spun. Spun poles shall be manufactured by a centrifugal spinning process with concrete pumped into a polished round tapered metal mold. Concrete for spun poles shall have a compressive strength of at least 5000 psi at 28 days; steel wire shall have an ultimate tensile strength of at least 120,000 psi; and reinforcing bars shall have an ultimate tensile strength of at least 40,000 psi. After the high speed spinning action is completed, a spun pole shall be cured by a suitable wet steam process. Spun poles shall have a water absorption of not greater than three percent to eliminate cracking and to prevent erosion. Concrete poles shall have hollow shafts. Poles shall have a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost. Poles shall not be installed for at least 15 days after manufacture. Fittings and brackets that conform to the concrete pole design shall be provided. Poles shall conform to strength calculations performed by a registered professional engineer and submitted in accordance with detail drawings portion of paragraph SUBMITTALS.

2.8.4 Pole Line Hardware

****

NOTE: In hot humid marine atmospheres, galvanized steel pole-line hardware may not be acceptable and only hot-dip galvanized malleable or ductile iron should be permitted. Local usage should be checked.

****

Zinc-coated hardware shall comply with ANSI C135.1, ANSI C135.2, ANSI C135.4, ANSI C135.14 ANSI C135.22. Steel hardware shall comply with ASTM A 575 and ASTM A 576. Hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M. Pole-line hardware shall be hot-dip galvanized [steel.] [steel, except anchor rods of the copper-molten welded-to-steel type with nonferrous corrosion-resistant fittings shall be used]. Washers shall be installed under boltheads and nuts on wood surfaces and elsewhere as required. Washers used on through-bolts and double-arming bolts shall be approximately 2-1/4 inches square and 3/16 inch thick. The diameter of holes in washers shall be the correct standard size for the bolt on which a washer is used. Washers for use under heads of carriage-bolts shall be of the proper size to fit over square shanks of bolts. Eye bolts, bolt eyes, eyenuts, strain-load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises shall be used wherever required to support and to protect poles, brackets, crossarms, guy wires, and insulators.

2.8.5 Armless Construction

Pole mounting brackets for line-post or pin insulators and eye bolts for suspension insulators shall be as shown. Brackets shall be attached to poles with a minimum of two bolts. Brackets may be either provided integrally as part of an insulator or attached to an insulator with a suitable stud. Bracket mounting surface shall be suitable for the shape of the pole. Brackets for wood poles shall have wood gripping members. Horizontal offset brackets shall have a 5-degree uplift angle. Pole top brackets shall conform to ANSI C135.22, except for modifications necessary to provide support for a line-post insulator. Brackets shall provide a strength exceeding that of the required insulator strength, but in no case less than a 2800 pound cantilever strength.

2.8.6 Guy Assemblies

Guy assemblies shall be [aluminum-clad steel in accordance with ASTM B 416] [copper-clad steel in accordance with ASTM B 228] [or] [zinc-coated steel in accordance with ASTM A 475]. Guy assemblies, including insulators and attachments, shall provide a strength exceeding the required guy strength. Three-eye thimbles shall be provided on anchor rods to permit attachment of individual primary, secondary, and communication down guys. Anchors shall provide adequate strength to support all loads. Guy strand shall be [3] [7] strand. Guy material shall be [Class [30 HS] [30 EHS] copper-clad steel] [Class [A] [B] [C] zinc-coated-steel [utilities] [high-strength] [extra-high-strength] grade] [or] [aluminum-clad-steel-strand], with a minimum breaking strength [not less than 6000 pounds] [[_____] pounds] [as shown], except where two or more guys are used to provide the required strength. Guy rods shall be not less than [7] [8] feet in length by [5/8] [3/4] [1] inch in diameter.

2.9   INSULATORS

****

NOTE: See TM 5-811-1 for guidance regarding insulators.

****

Insulators shall comply with NEMA HV 2 for general requirements. Suspension insulators shall be used at corners, angles, dead-ends, other areas where line insulators do not provide adequate strength, and as indicated. Mechanical strength of suspension insulators and hardware shall exceed the rated breaking strength of the attached conductors.

2.9.1   Medium-Voltage Line Insulators

****

NOTE: Specify the first value for dry areas or limited fog areas with moderate industry contamination. Specify the second value for more heavily contaminated areas.

****

Medium-voltage line insulators shall comply with ANSI C29.2, ANSI C29.5, and ANSI C29.6, and as applicable. Ratings shall not be lower than the ANSI classes indicated in TABLE I. Horizontal line-post insulators shall be used for armless construction and shall have the same mechanical and electrical ratings as vertical line-post insulators for the ANSI class indicated, but shall be modified to be suitable for horizontal installation. Where line-post insulators are used for angles greater than 15 degrees, clamp-top fittings shall be provided as well as for other locations shown. Conductor clamps for use with clamp-top, line-post insulators shall be hot-dip galvanized malleable iron for copper conductors and aluminum alloy for aluminum-composition conductors. Either line-post or pin insulators may be used for crossarm construction. Pin insulators for use on voltages in excess of 6 kV phase-to-phase shall be radio-interference-freed or else line-post insulators shall be used.

TABLE I

MINIMUM ANSI RATING OF MEDIUM-VOLTAGE INSULATORS BY CLASS

Voltage Level	Line-Post	Pin	Suspension
Up to 5 kV	57-1 or 11	55-3	One 52-1
	57-1 or 11	55-5	Two 52-1
6 kV to 15 kV	57-1 or 11	55-5	Two 52-2
	57-2 or 12	56-3	Two 52-3 or 4
16 kV to 25 kV	57-2 or 12	56-3	Two 52-3 or 4
	57-3 or 13	56-4	Three 52-3 or 4
26 kV to 35 kV	57-3 or 13	56-4	Three 52-3 or 4
	57-4 or 14	56-5	Four 52-3 or 4

2.9.2   Low-Voltage Line Insulators

Low-voltage line insulators shall comply with ANSI C29.2 and ANSI C29.3 as applicable. Spool insulators for use on low-voltage lines shall be mounted on clevis attachments or secondary racks and shall be not smaller than Class [53-2] [53-3]. For No. 4/0 AWG and larger conductors, Class [53-4] [53-5] shall be used. Suspension insulators on clevis attachments used at dead-ends shall be not smaller than Class 52-1.

2.9.3 Strain Insulators for Guy Wires

Strain insulators for use in insulated guy assemblies shall comply with ANSI C29.4 for porcelain or equivalent fiberglass, and shall have a mechanical strength exceeding the rated breaking strength of the attached guy wire. Insulators shall be not smaller than Class [54-1] [54-2] for lines up to 5 kV, not smaller than Class [54-2] [54-3] for lines of 6 kV to 15 kV, not smaller than Class [54-4] [54-4 with two in tandem] for lines of 16 kV to 25 kV, and not smaller than Class [54-4 with two in tandem] [54-4 with three in tandem] for lines of 26 kV to 35 kV.

2.9.4 Apparatus Insulators

Apparatus insulators shall comply with IEEE C57.19, IEEE C57.19.01, ANSI C29.8, and ANSI C29.9 as applicable.

2.10 CROSSARM ASSEMBLIES

2.10.1 Crossarms

Crossarms shall comply with RUS Bull 1728H-701 and shall be solid wood, distribution type, except cross-sectional area with pressure treatment conforming to AWPA C25, and a 1/4 inch, 45 degree chamfer on all top edges. Cross-sectional area minimum dimensions shall be 4-1/4 inches in height by 3-l/4 inches in depth in accordance with IEEE C2 for Grade B construction. Crossarms shall be 8 feet in length, except that 10 foot crossarms shall be used for crossarm-mounted banked single-phase transformers or elsewhere as indicated. Crossarms shall be machined, chamfered, trimmed, and bored for stud and bolt holes before pressure treatment. Factory drilling shall be provided for pole and brace mounting, for four pin or four vertical line-post insulators, and for four suspension insulators, except where otherwise indicated or required. Drilling shall provide required climbing space and wire clearances. Crossarms shall be straight and free of twists to within 1/10 inch per foot of length. Bend or twist shall be in one direction only.

2.11 AUTOMATIC CIRCUIT RECLOSERS

****

NOTE: Provide control cabinet location and mounting details on the drawings.

****

Automatic circuit reclosers shall comply with IEEE C37.60 and shall be outdoor oil or vacuum type, complete with devices, attachments, and accessories required for installation and operation and shall be suitable for mounting on a single pole. Each recloser shall have continuous current, minimum tripping current, interrupting current, and making current ratings and reclosure times as indicated and shall be rated for the voltage and phase of the system in which it is installed. Three-phase lockout shall be provided on three-phase circuits. Reclosers shall include provisions for a sequence of not less than three automatic reclosing operations unless otherwise noted, followed by lockout if the circuit fault persists, and for manual opening, closing, and lockout by use of a hookstick. Operating sequence shall be adjustable for 1, 2, 3, and 4 operations to lockout and for combinations of instantaneous operations followed by time delay openings to secure coordination with other reclosers and fuses in the medium-voltage distribution system. Reclosers shall automatically reset within a definite time interval after a successful reclosure and shall be supplied with devices needed to provide the necessary operating power. Hydraulically-controlled reclosers shall be provided with tank drains and sampling valves. Surge arrester protection shall be provided. [Reclosers shall be equipped with [ground fault tripping] [and] [three-phase current metering] equipment.]

2.12 CAPACITORS

Capacitor equipment shall comply with IEEE Std 18 and shall be of the three-phase, grounded-wye, outdoor type rated for continuous operation and automatically switched. Equipment shall be suitable for mounting on a single pole. Polychlorinated biphenyl and tetrachloroethylene (perchloroethylene) shall not be used as the dielectric. Equipment shall be rated for the system voltage. The indicated kvars shall be automatically switched by [single-step [time switch] [voltage] [current] [kilovar] control] [multiple-step [voltage] [kilovar] control providing the indicated number of steps and switching the indicated kvar]. Necessary transformers shall be provided for sensing circuit variations and for low-voltage control. Oil-immersed switches shall be provided for automatic switching of capacitors, and shall be electrically separate from ungrounded capacitor enclosures and metal frames. Installations shall include one primary fuse cutout and one surge arrester for each ungrounded phase conductor. Fuse link ratings shall be in accordance with the manufacturer's recommendations. Capacitor equipment, except for low-voltage control and primary fuse cutouts, shall be subassembled and coordinated by one manufacturer. Units, including metal pole-mounting supports and hardware, shall be shipped in complete sections ready for connection at the site. Low-voltage equipment shall be socket or cabinet type, mounted on the pole approximately 4 feet above grade, shall be connected with the necessary wiring in conduit to capacitor equipment, and shall be provided with secondary arrester protection against switching surges when recommended by the manufacturer.

2.13 FUSES AND SWITCHES, MEDIUM-VOLTAGE

****

NOTE: See TM 5-811-1 for guidance on the application of fuses and switches.

A short-circuit study is required to specify ratings. See TM 5-811-14 and CEGS-16475.

****

2.13.1 Fuse Cutouts

Medium-voltage fuses and cutouts shall comply with NEMA SG 2 and shall be of the [loadbreak] [nonloadbreak] [enclosed] [open] type construction [rated [5.2] [7.8] [15] [27] [38] kV and of the [normal] [heavy] [extra-heavy] [ultra-heavy]-duty type] [ratings and types indicated]. Open-link cut-outs are not acceptable. Fuses shall be either indicating or dropout type. Fuse ratings shall be as indicated. Fuse cutouts shall be equipped with mounting brackets suitable for the indicated installations.

2.13.2 Fused Switches

Fused switches shall be single-pole, manual devices with integral power fuses of the dropout type. Fuse ratings shall be as indicated. Each switch shall have a continuous current rating [of [400] [600] amperes rms] [as shown], a momentary asymmetrical current rating of [20] [40] kA rms [as shown] and shall be rated for the voltage of the system in which it is installed.

2.13.3 Nonfused Switches

Nonfused switches shall be single-pole, manual devices with a continuous current rating [of [100] [200] [400] [600] amperes rms] [as shown], a momentary asymmetrical current rating of [20] [40] kA rms [as shown], and shall be rated for the voltage of the system in which it is installed.

2.13.4 Group-Operated Load Interrupter Switches

2.13.4.1 Manually Operated Type (Switch Handle Operated)

Manually operated (switch handle operated) load interrupter switches shall comply with ANSI C37.32 and shall be of the outdoor, manually-operated, three-pole, single-throw type with either tilting or rotating insulators. Switches shall be equipped with interrupters capable of interrupting currents equal to the switch's continuous current rating. Each switch shall be preassembled for the indicated configuration and mounting. Moving contacts shall be of the high-pressure, limited-area type, designed to ensure continuous surface contact. Switches shall be fused or non-fused as indicated. Switches shall be complete with necessary operating mechanisms, handles, and other items required for manual operation from the ground. Switch operating handles shall be located approximately 3 feet 6 inches above final grade. Insulation of switch operating mechanisms shall include both insulated interphase rod sections and insulated vertical shafts. Each handle shall be provided with a padlock arranged to lock the switch in both the open and the closed position.

2.13.4.2 Remotely Operated Type (Stored-Energy Actuator)

****

NOTE: SF6 switches are available for nominal voltages of 15 kV through 34.5 kV in 600 ampere continuous and load-break ratings. Delete SCADA equipment and remote telemetry when not required.

****

Remotely-operated, [air-insulated] [SF6 insulated] load interrupter switches shall be rated in accordance with and comply with the requirements of ANSI C37.32 and shall be of the outdoor, three-pole, [pole-mounted] [crossarm-mounted] type. Interrupter devices shall be [air-insulated] [SF6-insulated, puffer-type] switches capable of interrupting currents equal to the switch continuous current ratings indicated. Switches shall utilize an electric motor-charged, stored-energy (spring-driven) operator to simultaneously trip all phases. A switch-control unit shall be provided [for push-button operation from the ground] [for push-button operation from the ground and remote switch actuation via telemetry]. The switch-control unit shall be pad-lockable, tamper-resistant, in a NEMA ICS 6, Type [3R] [4] [4X] [4X-SS] enclosure, which is connected to the switch actuator by a shielded control cable. Control power for closing and tripping shall be provided by a battery mounted in the control unit enclosure. The switch control unit shall be provided with a separate 120 volt ac circuit for the battery powered. Power for charging the operator mechanism may be 120 volt ac or battery powered. If operator mechanism charging power is from a battery, capacity shall be provided for a minimum of [_____] [four] sequential opening and closing operation without battery charging. The switch control unit shall be configured for supervisory, control, and data acquisition (SCADA) function, including local and remote operation. Voltage and current sensors shall be provided, one set for each phase, for monitoring of both normal and fault conditions. Switches shall be provided with visual indication of open switch contact for clearance and isolation purposes. Switch mechanisms shall be provided with provisions for grounding of nonenergized metal parts. The switch control unit shall be provided with a switch operations.

2.13.5   Group Operated Load Interrupter Switches

****

NOTE: SF6 switches are available for nominal voltages of 15 kV through 34.5 kV, in 600 amp continuous and load-breaking ratings. Delete SCADA equipment and remote telemetry when not required.

****

2.13.5.1   Remotely Operated (Stored-Energy Actuator)

Remotely-operated, group-operated, air insulated load interrupter switches shall comply with ANSI C37.32 and shall be of the outdoor, three-pole, pole or crossarm-mounted type. The electrical ratings of remotely-operated, group-operated, gas-insulated load interrupter switches shall be in accordance with the ratings of ANSI C37.32 and shall be of the outdoor, three-pole, [pole-mounted] [crossarm-mounted] type. Interrupting devices shall be [air-insulated switches] [SF6 insulated, puffer-type switches] capable of interrupting currents equal to the switch continuous ratings indicated.

2.13.5.2   Electric-Motor-Charged (Stored-Energy Actuator)

Switches shall utilize an electric-motor-charged, stored-energy (spring-driven) operator to simultaneously trip all phases. A switch-control unit shall be provided [for push-button operation from the ground] [for push-button operation from the ground and remote switch actuation via remote telemetry]. The switch-control unit shall be pad-locked, tamper-resistant, NEMA ICS 6 type [3R] [4] [4X] [4X-SS] enclosure, which is connected to the switch actuator by a shielded control cable. Control power for closing and tripping shall be provided by a battery mounted in the control unit enclosure. The switch-control unit shall be provided with separate 120 volt ac circuit for the battery charger. Power for charging the operator mechanism, may be 120 V ac power or provided from battery power. If operating mechanism charging power is battery, capacity shall be provided for a minimum of [_____] [four] sequential opening and closing operations, without battery charging. The switch-control unit shall be configured for supervisory control, and data acquisition (SCADA) function, including local and remote operation. Voltage and current sensors shall be provided one set for each phase, for monitoring of both normal and fault conditions. Switches shall be provided with visual indication of open switch contact for clearance and isolation purposes. Switch mechanism shall be provided with provisions for grounding of non-energized metal parts. The switch-control unit shall be provided with a switch operations counter.

2.13.5.3 Pole-Mounted Sectionalizing Switches

Pole-mounted sectionalizing switches shall comply with IEEE C37.63. Sectionalizers shall be coordinated with source side recloser as shown. Ratings at 60 Hz shall be:

Nominal voltage .... [_____]

Rated Maximum voltage .... [_____]

Rated continuous current .... [_____]

Three second short-time current-carrying capacity .... [_____]

BIL .... [_____]

2.14 ILLUMINATION

****

NOTE: Refer to CEGS-16528, EXTERIOR LIGHTING INCLUDING SECURITY AND CCTV APPLICATIONS for illumination requirements.

****

2.15 TRANSFORMERS

Transformers shall comply with IEEE C57.12.00 for general requirements and ANSI C57.12.20 for specific requirements for overhead transformers. Overhead distribution transformers shall be of the outdoor type, [mineral-oil-insulated] [less-flammable liquid-insulated with [high molecular-weight-hydrocarbon] [or] [dimethyl silicone] liquid] single-phase or three-phase as indicated and have two separate windings per phase. Transformers shall be provided with necessary auxiliary mounting devices suitable for the indicated installation. Transformers shall have [four 2-1/2 percent] [two 2-1/2 percent] [two 5 percent] rated kVA high-voltage taps [above] [and] [below] rated primary voltage. Transformer installations shall include one primary fuse cutout and one surge arrester for each ungrounded phase conductor. Self-protected transformers are not acceptable. Transformer tanks shall have a standard [gray] [_____] finish.

2.16 SURGE ARRESTERS

Surge arresters shall comply with NEMA LA 1 and IEEE C62.1, IEEE C62.2, and IEEE C62.11, and shall be provided for protection of aerial-to-underground transitions, automatic circuit reclosers, capacitor equipment, group-operated load-interrupter switches, transformers and other indicated equipment. Arresters shall be [station] [intermediate] [distribution] class, rated as shown. [Arresters for use at elevations in excess of 6000 feet above mean sea level shall be specifically rated for that purpose.] Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be of the [valve] [or] [metal-oxide varistor] [or] [combination valve-metal-oxide varistor] type suitable for outdoor installations.

2.17 VOLTAGE REGULATOR

****

NOTE: Bypass arresters are normally standard equipment. Incoming line arresters may not be needed. Coordinate with the manufacturer.
****

Voltage regulators shall comply with IEEE C57.15 and shall be of the outdoor, self-cooled, 55/65 degrees C temperature rise, single-phase type. Windings and the load-tap-changing mechanism shall be mineral-oil-immersed. When operating under load, a regulator shall provide plus and minus 10 percent automatic voltage regulation in approximately 5/8 percent steps, with 16 steps above and 16 steps below rated voltage. Automatic control equipment shall provide Class 1 accuracy. Bypass surge arresters shall be suitable for [a grounded] [an ungrounded] system and for the associated regulator voltage. [[Station] [Intermediate] class surge arresters shall be mounted next to each incoming line bushing on a regulator tank-mounted bracket and connected to a surge arrester ground pad-mounted on the regulator tank.]

2.17.1 Ratings

Ratings at 60 Hz shall be

Maximum voltage..[_____]

Basic Insulation Level (BIL)..............................[_____]

Current..[_____]

2.17.2 Bypass and Isolation Switches

Switches shall be of the outdoor, stickhook-operated, single-pole, single-throw, vertical-break type suitable for the indicated mounting. Switches shall be of a type designed to provide bypass of a single-phase regulator circuit by an integral sequence which always occurs when each switch is opened or closed. Each opening sequence shall initially bypass the single-phase regulator circuit, then open the input and output circuits, and finally interrupt the exciting current. Opening any single-phase regulator circuit shall not be possible until after the bypass circuit is closed. Ratings at 60 Hz shall be in accordance with IEEE C37.41 and as follows:

Maximum voltage..[_____]

Nominal voltage class....................................[_____]

BIL..[_____]

Momentary asymmetrical current in the closed position.....[_____]

Momentary asymmetrical current in the bypass position.....[_____]

Continuous and interrupting current......................[_____]

2.17.3 Miscellaneous

Standard accessories and components in accordance with IEEE C57.15shall be provided. Single-phase units shall be provided with additional components and accessories required by IEEE C57.15 for three-phase units.

2.18   GROUNDING AND BONDING

2.18.1   Driven Ground Rods

Ground rods shall be of [copper-clad steel conforming to UL 467] [zinc-coated steel conforming to ANSI C135.30] [solid stainless steel] not less than [5/8] [3/4] inch in diameter by [8] [10] feet in length of the sectional type driven full length into the earth.

2.18.2   Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as the phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

2.19   PADLOCKS

Padlocks shall comply with Section 08700 'Builders' Hardware.

2.20   WARNING SIGNS

Warning signs shall be porcelain enameled steel or approved equal. Voltage warning signs shall comply with IEEE C2.

2.21   LIQUID DIELECTRICS

****
NOTE: Select 2 ppm for Air Force projects.
****

Liquid dielectrics for transformers, capacitors, reclosers, and other liquid-filled electrical equipment shall be non-polychlorinated biphenyl (PCB) mineral-oil or less-flammable liquid as specified. Nonflammable fluids shall not be used. Tetrachloroethylene (perchloroethylene) and 1, 2, 4 tetrachlorobenzene fluids shall not be used. Liquid dielectrics in retrofitted equipment shall be certified by the manufacturer as having less than [50] [2] parts-per-million (ppm) PCB content. In lieu of the manufacturer's certification, the Contractor may submit a test sample of the dielectric in accordance with ASTM D 923 and have tests performed per ASTM D 4059 at a testing facility approved by the Contracting Officer. Equipment with test results indicating PCB level exceeding [50] [2] ppm shall be replaced.

2.22   FACTORY TESTS

****
NOTE: Delete tests that are not applicable to the project. Refer to TM 5-811-1. Tests must be justified.
****

Factory tests shall be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified at least [10] [_____] days before the equipment is ready for testing.

a. Transformers: Manufacturer's standard [routine] [design] [and] [other] tests in accordance with IEEE C57.12.00.

b. Transformers rated 200 kVA and above: Reduced full-wave, chopped-wave, and full-wave impulse test on each line [and neutral] terminal, in accordance with IEEE C57.98.

c. High-Voltage Air Switches: Manufacturer's standard tests in accordance with IEEE C37.34 and IEEE C37.41.

d. Instrument Current Transformers: Manufacturer's standard tests in accordance with IEEE C57.13.2.

e. Voltage Regulators: Manufacturer's standard tests in accordance with IEEE C57.15.

f. High-Voltage Fuses: Manufacturer's standard tests in accordance with IEEE C37.41.

g. Electric Power Insulators: Manufacturer's standard tests in accordance with ANSI C29.1.

h. [_____]

2.23 COORDINATED POWER SYSTEM PROTECTION

****

NOTE: The requirement for the studies in this section depends on the complexity and extent of the power system. Delete this requirement for projects of limited scope; projects having protective devices which are not adjustable or for which coordination is not possible (standard molded case circuit breakers); projects involving simple extension of 600 volt level service to a building or facility from an existing transformer (750 kVA or less), or projects involving simple extension of 600 volt level service to a building or facility from a new transformer (750 kVA or less).

The designer will be responsible for showing and specifying the requirements for fuses, circuit breakers, protective relays, or other protective devices associated with the project. The protective devices should be selected and specified to protect electrical power system conductors or equipment against sustained overloads, in-rush conditions, electrical faults, or other abnormal power system or equipment operating conditions, in accordance with TM 5-811-14, COORDINATED POWER SYSTEM PROTECTION and IEEE Std 242, and IEEE Std 141.

The complexity and extent of coordinated power system protection depends on the type of buildings or facilities or utilities required, on the load demand of facilities, and on the quantity and types of facilities to be constructed. Facilities having

a relatively-low power demand(e.g., 2,500 kVA or less) generally require protection of an incoming aerial distribution line or underground, medium-voltage feeder, low-voltage feeders to individual items of equipment, or to power distribution equipment; and branch circuits. More complex projects such as facilities with generating capacity, large motors, or larger load demands, will require more detailed and extensive coordinated power system protection.

Independent of the type or types of facilities or load demands, the coordinated power system protection will be based on: economics, simplicity, and the electrical power availability dictated by the Using Agency or Service, or by the functional use of the facilities or utilities; required to provided maximum power service with a minimum of power interruptions, and the operating speed of protective devices required to minimize damage to electrical components or items of equipment and to prevent injury to personnel and nuisance tripping.

Unless otherwise approved, a dc power source will be shown and specified to ensure proper closing and tripping of protective devices which require a reliable power source during outage of the normal alternating-current power source.
****

Analyses shall be prepared to demonstrate that the equipment selected and system constructed meet the contract requirements for equipment ratings, coordination, and protection. They shall include a load flow analysis, a fault current analysis, and a protective device coordination study. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last three years. The Contractor shall provide list of references complete with points of contact, address and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

2.23.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: [the source bus and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses.] [the source bus and extend through the secondary side of transformers for medium voltage distribution.] [the source bus and extend through [outgoing breakers] [outgoing medium voltage feeders, down to the individual protective devices for medium voltage radial taps] [outgoing medium voltage feeders, through the secondary side of transformers] [as indicated] for main electric supply substations.] [the nearest upstream device in the existing source system and extend through the downstream devices at the load end.]

2.23.2 Determination of Facts

****

NOTE: Require the Contractor to obtain an available fault capacity at the power source or provide a fault capacity on which he is to base his analysis. Delete the unused option.
****

The time-current characteristics, features, and nameplate data for each existing protective deice shall be determined and documented. [The Contractor shall coordinate with the [commercial power company] [_____] for fault current availability at the site.] [The Contractor shall utilize the fault current availability indicated as a basis for fault current studies.]

2.23.3 Single Line Diagram

A single line diagram shall be prepared to show the electrical system buses, devices, transformer points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformer point shall have a unique identifier. If a fault-impedance diagram is provided, impedance data shall be shown. Locations of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

2.23.4 Fault Current Analysis

2.23.5 Method

The fault current analysis shall be performed in accordance with methods described in IEEE Std 242 and IEEE Std 399.

2.23.6 Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedances shall be those proposed. Data shall be documented in the report.

2.23.7 Fault Current Availability

Balanced three-phased fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.

2.23.8 Coordination Study

The study shall demonstrate that the maximum possible degree of selectively has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study shall include a description of the coordination of the protective devices in this project. Provide a written narrative that describes: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap); coordination between upstream and downstream devices; and relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost changes (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

2.23.9 Study Report

a. The report shall include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.

b. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.

c. The report shall document [utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristics curves, current transformer ratios, and relay device numbers and settings;] [and] [existing power system data including time-current characteristics curves and protective device ratings and settings.]

d. The report shall contain fully coordinated composite time-current characteristic curves for each bus in the system, as required to ensure coordinated power system between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.

e. The report shall provide the calculation performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Circuits installed in conduits or underground and splices and terminations for medium-voltage cable shall conform to the requirements of Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Secondary circuits installed in conduit on poles shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR.

3.1.1 Conformance to Codes

****

NOTE: Plans should indicate where IEEE C2applies and where NFPA 70 applies.

****

The installation shall comply with the requirements and recommendations of IEEE C2 for [heavy] [medium] [light] loading districts, Grade B construction. No reduction in clearance shall be made. The installation shall also comply with the applicable parts of NFPA 70.

3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall notify the Contracting Officer of any discrepancy before performing any work.

3.1.3 Tree Trimming

****
NOTE: Indicate on contract drawings where a cleared right-of-way is required. If no cleared right-of-way is required delete the last sentence. Where local practices for tree trimming clearances exceed those shown, follow local practice.
****

Where lines pass through trees, trees shall be trimmed at least 15 feet [_____] clear on both sides horizontally and below for medium-voltage lines, and [_____] 5 feet clear on both sides horizontally and below for other lines, and no branch shall overhang horizontal clearances. Where trees are indicated to be removed to provide a clear right-of-way, clearing is specified in Section 02230 CLEARING AND GRUBBING.

3.1.4 Disposal of Liquid Dielectrics

PCB-contaminated dielectric shall be marked as PCB and transported to and incinerated by an approved EPA waste disposal facility. The Contractor shall furnish certification of proper disposal. Contaminated dielectric shall not be diluted to lower the level of contamination.

3.2 POLE INSTALLATION

Joint-use electric/roadway-lighting poles for overhead electric and communication lines shall be [wood] [steel] [concrete] poles utilizing [armless] [crossarm] construction. [Cluster-mounted] [Cross-arm mounted] banked single-phase transformer installations shall be provided. [Crossarm construction shall be provided for support of other equipment, except where direct-pole mounting is indicated.] [Pole equipment mounts shall be used for steel and concrete poles and may be used for wood poles rather than crossarm equipment mounts. Detail drawings shall be submitted for approval.] Provision for communication services is required on pole-line construction, except where specifically noted otherwise. A vertical pole space of not less than [2 feet] [_____] shall be reserved at [indicated] [all] locations.

3.2.1 Wood Pole Setting

****
NOTE: Where specific pole setting depths cannot be given because the type of soil is unknown, use the second bracketed choice; otherwise detail requirements.
****

Wood Pole Setting: Wood poles shall be set straight and firm. In normal firm ground, minimum pole-setting depths shall be as listed in Table II. In rocky or swampy ground, pole-setting depths shall be decreased or increased [as shown] [respectively in accordance with the local utility's published standards and as approved]. In swampy or soft ground, a bog shoe shall be used where support for a pole is required. Poles in straight runs shall be in a straight line. Curved poles shall be placed with curvatures in the direction of the pole line. Poles shall be set to maintain as even a grade as practicable. When the average ground run is level, consecutive poles shall not vary more than 5 feet in height. When the ground is uneven, poles differing in length shall be kept to a minimum by locating poles to avoid the highest and lowest ground points. If it becomes necessary to shorten a pole, a piece shall be sawed off the top end and roofed. If any pole is shortened after treatment, the shortened end of the pole shall be given an application of hot preservative. Where poles are set on hilly terrain, along edges of cuts or embankments, or where soil may be washed out, special precautions shall be taken to ensure durable pole foundations, and the setting depth shall be measured from the lower side of the pole. Holes shall be dug large enough to permit proper use of tampers to the full depth of a hole. Earth shall be placed into the hole in 6 inch maximum layers, then thoroughly tamped before the next layer is placed. Surplus earth shall be placed around each pole in a conical shape and packed tightly to drain water away from poles.

TABLE II

MINIMUM POLE-SETTING DEPTH (FEET)

Length Overall Feet	Straight Lines	Curves, Corners, and Points of Extra Strain
20	5.0	5.0
25	5.5	5.5
30	5.5	5.5
35	6.0	6.0
40	6.5	6.5
45	6.5	7.0
50	7.0	7.5
55	7.5	8.0
60	8.0	8.5
65	8.5	9.0
70	9.0	9.5
75	9.5	10.0
80	10.0	10.5
85	10.5	11.0
90	11.0	11.5
95	11.5	12.0
100	12.5	12.5

3.2.2 Aluminum, Steel, and Concrete Pole Setting

Poles shall be mounted on cast-in-place or power-installed screw foundations. Concrete poles shall be embedded in accordance with the details shown. Conduit elbows shall be provided for cable entrances into pole interiors.

3.2.2.1 Cast-In-Place Foundations

Concrete foundations, sized as indicated, shall have anchor bolts accurately set in foundations using templates supplied by the pole manufacturer. Concrete work and grouting is specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. After the concrete has cured, pole anchor bases shall be set on foundations and leveled by shimming between anchor bases and foundations or by setting anchor bases on leveling nuts and grouting. Poles shall be set plumb. Anchor bolts shall be the manufacturer's standard, and not less than necessary to meet the pole wind loading specified herein and other design requirements.

3.2.2.2 Power-Installed Screw Foundations

Power-installed screw foundations may be used if they have the required strength, mounting-bolt, and top plate dimensions. Screw foundations shall be of at least 1/4 inch thick structural steel conforming to ASTM A 36/A 36M and hot-dip galvanized in accordance with ASTM A 123/A 123M. Conduit slots in screw foundation shafts and top plates shall be marked to indicate orientation. Design calculations indicating adequate strength shall be approved before installation of screw foundation is permitted. Calculations shall be submitted in accordance with the detail drawings portion of paragraph SUBMITTALS.

3.3 CROSSARM MOUNTING

****

NOTE: Normally flat braces will be specified for 2.4 m (8 foot) crossarms and angle braces for 3.1 m (10 foot) crossarms to agree with REA construction. An angle brace is also required on 2.4 m (8 foot) arms where conductors have a breaking strength of more than 20.0 kN (4500 pounds). Extreme loading conditions may also warrant the extra cost of the stronger angle brace under other circumstances.

Metal crossarm braces will reduce the effective BIL rating of the pole. In high lightning areas specify fiberglass braces.

Consult REA Bulletin 61-10, "Protection of Bald and Golden Eagles from Powerlines." The requirement for wooden crossarm braces should be verified for each state and land area in accordance with the Bald Eagle Protection Act of 1940, (16 U.S.C. 703 et seq.) as amended; Endangered Species Act of 1973 (87 Stat. 1064); and Migratory Bird Treaty of 1918 (16 U.S.C 703 et. seq.) as amended. Potential requirement sources are the Bureau of Land Management, U.S. Department of the Interior, and Federal, State, and Local Land Management or Wildlife Conservation Agencies.

****

Crossarms shall be bolted to poles with 5/8 inchthrough-bolts with square washers at each end. Bolts shall extend not less than 1/8 inch nor more than 2 inches beyond nuts. On single crossarm construction, the bolt head shall be installed on the crossarm side of the pole. [Fiberglass] [Metal] [Wood] crossarm braces shall be provided on crossarms. Flat braces may be provided for 8 foot crossarms and shall be 1/4 by 1-1/4 inches, not less than 28 inches in length. Flat braces shall be bolted to arms with 3/8 inch carriage bolts with round or square washers between boltheads and crossarms, and secured to poles with 1/2 by 4 inch lag screws after crossarms are leveled and aligned. Angle braces are required for 10 foot crossarms and shall be 60 inch span by 18 inch drop formed in one piece from 1-1/2 by 1-1/2 by 3/16 inch angle. Angle braces shall be bolted to crossarms with 1/2 inch bolts with round or square washers between boltheads and crossarms, and secured to poles with 5/8 inch through-bolts. Double crossarms shall be securely held in position by means of 5/8 inch double-arming bolts. Each double-arming bolt shall be equipped with four nuts and four square washers.

3.3.1 Line Arms and Buck Arms

Line arms and buck arms shall be set at right angles to lines for straight runs and for angles 45 degrees and greater; and line arms shall bisect angles of turns of less than 45 degrees. Dead-end assemblies shall be used for turns where shown. Buckarms shall be installed, as shown, at corners and junction poles. Double crossarms shall be provided at ends of joint use or conflict sections, at dead-ends, and at angles and corners to provide adequate vertical and longitudinal strength. Double crossarms shall be provided at each line-crossing structure and where lines not attached to the same pole cross each other.

3.3.2 Equipment Arms

Equipment arms shall be set parallel or at right angles to lines as required to provide climbing space. Equipment arms shall be located below line construction to provide necessary wire and equipment clearances.

3.4 GUY INSTALLATION

****

NOTE: Paragraph GUY INSTALLATION. Local practice will determine whether guy strain insulators are provided on guys for wood poles. Normally where guys are not grounded by connection to neutrals or overhead grounding conductors, guys will be insulated (sectionalized) and are considered ungrounded. Some areas require insulators on guys exposed to voltages of less than 22.5 kV, but not for greater voltages unless simultaneously exposed to voltages below 22.5 kV. Strain insulators will prevent a cathodic couple between the anchor and ground rod via the guy and the neutral grounding conductor.

A soil survey should be completed early in the design to properly select the type of anchor.

****

Guys shall be provided where shown, with loads and strengths as indicated, and wherever conductor tensions are not balanced, such as at angles, corners, and dead-ends. Where a single guy will not provide the required strength, two or more guys shall be provided. Where guys are wrapped around poles, at least two guy hooks shall be provided and pole shims shall be provided where guy tension exceeds 6000 pounds. Guy clamps 6 inches in length with three 5/8 inch bolts, or offset-type guy clamps, or approved guy grips shall be provided at each guy terminal. Guy-strain insulators shall be provided in each guy for wood poles. Multiple-helix screw anchors shall be provided in marshy ground; rock anchors shall be installed in rock at right angles to guys, elsewhere anchors shall be of an expanding type, except that power installed screw anchors of equivalent holding power are acceptable. A half-round [yellow] [gray] [_____] polyvinyl, fiberglass, or other suitable plastic guy marker, not less than 8 feet in length, shall be provided at the anchor end of each guy shown, securely clamped to the guy or anchor at the bottom and top of the marker. Holding capacities for down guys shall be based on a lead angle of [45 degrees] [as indicated].

3.5 CONDUCTOR INSTALLATION

3.5.1 Line Conductors

Unless otherwise indicated, conductors shall be installed in accordance with manufacturer's approved tables of sags and tensions. Proper care shall be taken in handling and stringing conductors to avoid abrasions, sharp bends, cuts, kinks, or any possibility of damage to insulation or conductors. Conductors shall be paid out with the free end of conductors fixed and cable reels portable, except where terrain or obstructions make this method unfeasible. Bend radius for any insulated conductor shall not be less than the applicable NEMA specification recommendation. Conductors shall not be drawn over rough or rocky ground, nor around sharp bends. When installed by machine power, conductors shall be drawn from a mounted reel through stringing sheaves in straight lines clear of obstructions. Initial sag and tension shall be checked by the Contractor, in accordance with the manufacturer's approved sag and tension charts, within an elapsed time after installation as recommended by the manufacturer.

3.5.2 Connectors and Splices

Connectors and splices shall be mechanically and electrically secure under tension and shall be of the nonbolted compression type. The tensile strength of any splice shall be not less than the rated breaking strength of the conductor. Splice materials, sleeves, fittings, and connectors shall be noncorrosive and shall not adversely affect conductors. Aluminum-composition conductors shall be wire brushed and an oxide inhibitor applied before making a compression connection. Connectors which are factory-filled with an inhibitor are acceptable. Inhibitors and compression tools shall be of types recommended by the connector manufacturer. Primary line apparatus taps shall be by means of hot line clamps attached to compression type bail clamps (stirrups). Low-voltage connectors for copper conductors shall be of the solderless pressure type. Noninsulated connectors shall be smoothly taped to provide a waterproof insulation equivalent to the original insulation, when installed on insulated conductors. On overhead connections of aluminum and copper, the aluminum shall be installed above the copper.

3.5.3 Conductor-To-Insulator Attachments

Conductors shall be attached to insulators by means of clamps, shoes or tie wires, in accordance with the type of insulator. For insulators requiring conductor tie-wire attachments, tie-wire sizes shall be as indicated in TABLE II.

TABLE II

TIE-WIRE REQUIREMENTS

CONDUCTOR Copper (AWG)	TIE WIRE Soft-Drawn Copper (AWG)
6	8
4 and 2	6
1 through 3/0	4
4/0 and larger	2
AAC, AAAC, or ACSR (AWG)	AAAC OR AAC (AWG)
Any size	6 or 4

3.5.4 Armor Rods

Armor rods shall be provided for AAC, AAAC, and ACSR conductors. Armor rods shall be installed at supports, except armor rods will not be required at primary dead-end assemblies if aluminum or aluminum-lined zinc-coated steel clamps are used. Lengths and methods of fastening armor rods shall be in accordance with the manufacturer's recommendations. For span lengths of less than 200 feet, flat aluminum armor rods may be used. Flat armor rods, not less than 0.03 by 0.25 inch shall be used on No. 1 AWG AAC and AAAC and smaller conductors and on No. 5 AWG ACSR and smaller conductors. On larger sizes, flat armor rods shall be not less than 0.05 by 0.30 inches. For span lengths of 200 feet or more, preformed round armor rods shall be used.

3.5.5 Medium-Voltage Insulated Cables

****

NOTE: Provide storm guying in extreme wind loading districts as defined by IEEE C2 and elsewhere when more than normal conductor loading occurs.

****

Medium-voltage cable messengers shall be attached to poles with clamps providing a strength exceeding the required messenger strength and with not less than 5/8 inch through-bolts. Messengers shall be dead-ended, grounded, [and] [and storm and] line-guyed at corners and dead-ends, and at intervals not exceeding 1000 feet along straight runs.

3.5.6 Low-Voltage Insulated Cables

****

NOTE: Due to both space requirements and the unattractive appearance, line conductors on secondary racks will be limited to special circumstances.

****

Low-voltage cables shall be supported on clevis fittings using spool insulators. Dead-end clevis fittings and suspension insulators shall be provided where required for adequate strength. Dead-end construction shall provide a strength exceeding the rated breaking strength of the neutral messenger. Clevis attachments shall be provided with not less than 5/8 inch through-bolts. Secondary racks may be used when installed on wood poles and where the span length does not exceed 200 feet. Secondary racks shall be two-, three-, or four-wire, complete with spool insulators. Racks shall meet strength and deflection requirements for heavy-duty steel racks, and shall be either galvanized steel or aluminum alloy. Tops of insulator saddles shall be rounded and smooth to avoid damage to conductor insulation. Each insulator shall be held in place with a 5/8 inch button-head bolt equipped with a nonferrous cotter pin, or equivalent, at the bottom. Racks for dead-ending four No. 4/0 AWG or four larger conductors shall be attached to poles with three 5/8 inch through-bolts. Other secondary racks shall be attached to poles with at least two 5/8 inch through-bolts. Minimum vertical spacing between conductors shall not be less than 8 inches.

3.6 TRANSFORMER INSTALLATION

****

NOTE: Specify phase sequence in accordance with the local practice.

****

Transformers shall be carefully installed so as not to scratch finishes or damage bushings. Transformers shall be installed in accordance with the manufacturer's instructions. After installation, surfaces shall be inspected and scratches shall be touched up with a finish provided by the transformer manufacturer for this purpose. Three-phase transformer installations shall be installed with [_____] phase sequence. Primary taps shall be set at [_____].

3.7 CONNECTIONS TO UTILITY LINES

****

NOTE: This paragraph will be further developed to suit the conditions of any connections required to the serving utility's lines.

****

The Contractor shall coordinate the work with the Contracting Officer and shall provide for final connections to the [utility] [installation] electric lines.

3.8 CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

Connections between aerial and underground systems shall be made as shown. Underground cables shall be extended up poles in [guards] [conduit] to cable terminations. Conduits shall be secured to poles by [conduit supports] [two-hole galvanized steel pipe straps] spaced not more than 10 feet apart and with one support not more than 12 inches from any bend or termination. Cables shall be supported by devices separate from the conduit or guard, near their point of exit from the riser conduit or guard. Cables guards shall be secured in accordance with the manufacturers published procedure. Risers shall be equipped with bushings to protect cables. Capnut potheads shall be used to terminate medium-voltage multiple-conductor cable.

3.9 CONNECTIONS TO BUILDINGS

3.9.1   Aerial Services

Connections to buildings shall be made at approximately the point indicated and shall be connected to the service entrance conductors. Supports at buildings shall be adequate to withstand required pulls; supports shall not be rated less than 1000 pounds. Drip loops shall be formed on conductors at entrances to buildings, cabinets, or conduits. Service-entrance conduits with termination fittings and conductors within the building, including sufficient slack for connection to aerial service cables, shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR.

3.9.2   Underground Services

Connections to buildings shall be made at the point indicated and shall be terminated at the service entrance equipment terminals. Cable pulling shall be in accordance with Section 16375, ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Service entrance conduits with termination fittings and conductors within the building shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR.

3.10   GROUNDING

****

NOTE: The designer will specify the grounding configuration and the number and type of electrodes required. See TM 5-811-1 for guidance. Coordinate with NFPA 70 and IEEE C2.

Some state codes do not permit grounding of metallic items mounted on wood poles above a certain height.

In some states it is standard practice to ground all noncurrent-carrying metal parts on all poles. Grounding all hardware on a pole reduces the natural BIL levels afforded with wood crossarm construction. While reduced BIL levels in high lightning incidence areas may result in more insulation flashovers, bonding all hardware will result in fewer pole fires.

****

Noncurrent-carrying metal parts of equipment and conductor assemblies, such as luminaires, medium-voltage cable terminations and messengers, metal poles, operating mechanisms of pole top switches, panel enclosures, transformers, capacitors, recloser frames (cases) and other noncurrent-carrying metal items shall be grounded. Additional grounding of equipment, neutral, and surge arrester grounding systems shall be installed at poles where indicated.

3.10.1   Grounding Electrodes

****

NOTE: Modify and/or delete paragraphs in accordance with project requirements.

The designer should investigate the soil resistivity during the preliminary design phase to determine the

design required to ensure that the grounding values are obtained. For areas where the water table is low and/or the soil resistivity is high (such as volcanic soils, sand, or rock), delete the additional electrode provisions and provide a design to meet the site requirements.
****

Grounding electrodes shall be installed as follows:

a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be located approximately 3 feet out from base of the pole and shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade. Multiple rods shall be evenly spaced at least 10 feet apart and connected together 2 feet below grade with a minimum No. 6 bare copper conductor.

b. Pole butt electrodes - Pole butt electrodes shall be installed where indicated, except that this method shall not be the sole grounding electrode at transformer locations. The pole butt electrode shall consist of a coil of at least 12 feet of minimum No. 6 bare copper conductor stapled to the butt of the pole.

c. Plate electrodes - Plate electrodes shall be installed in accordance with the manufacturer's instructions and IEEE C2 and NFPA 70.

d. Ground Resistance - The maximum resistance of a [driven ground rod] [pole butt electrode] [plate electrode] shall not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, provide additional electrodes [interconnected with grounding conductors] [as indicated], to achieve the specified ground resistance. The additional electrodes will be [up to three, [8 feet][10 feet] rods spaced a minimum of 10 feet apart], [a single extension-type rod, 5/8 inch 3/4 inch diameter, up to 30 feetlong, [driven perpendicular to grade] [coupled and driven with the first rod]]. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notifies immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

3.10.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors in compliance with UL 467, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

3.10.3 Grounding Electrode Conductors

****
NOTE: Provide a "detail."
****

On multi-grounded circuits, as defined in IEEE C2, provide a single continuous vertical grounding electrode conductor. Neutrals, surge arresters, and equipment grounding conductors shall be bonded to this conductor. For single grounded or ungrounded systems, provide a grounding conductor for the surge arrester and equipment grounding conductors and a separate grounding conductor for the secondary neutrals. Grounding electrode conductors shall be sized as shown. Secondary system neutral conductors shall be connected directly to the transformer neutral bushings, then connected with a neutral bonding jumper between the transformer neutral bushing and the vertical grounding electrode conductor, as shown. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 2 feet. On metal poles, a preformed galvanized steel strap, 5/8 inch wide by 22 gauge minimum by length, secured by a preformed locking method standard with the manufacturer, shall be used to support a grounding electrode conductor installation on the pole and spaced at intervals not exceeding 5 feet with one band not more than 3 inches from each end of the vertical grounding electrode conductor. Bends greater than 45 degrees in grounding electrode conductor are not permitted.

3.11 FIELD TESTING

****
NOTE: Select types to suit project conditions and delete all others. Delete all paragraphs not applicable. Tests must be justified.
****

3.11.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer [_____] days prior to conducting tests. The Contractor shall furnish materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field reports will be signed and dated by the Contractor.

3.11.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.11.3 Ground-Resistance Tests

The resistance of [each grounding electrode system] [each pole ground] [_____] shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes shall be provided.

3.11.4   Medium-Voltage Preassembled Cable Test

****

NOTE: If the installation is tapping a new feeder to an existing feeder using a "T" splice, modify the paragraph to indicate that when existing cable cannot be readily disconnected, the system should only be tested to the lower (after installation) voltage. Delete the test if no cable is installed in the project.

****

After installation, prior to connection to an existing system, and before the operating test, the medium-voltage preassembled cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors at one terminal and connecting grounds or metallic shieldings or sheaths of the cable at the other terminal for each test. Prior to the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with NEMA WC 7 or NEMA WC 8 for the particular type of cable installed, and shall not exceed the recommendations of IEEE Std 404 for cable joints unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

3.11.5   Sag and Tension Test

The Contracting Officer shall be given prior notice of the time schedule for stringing conductors or cables serving overhead medium-voltage circuits and reserves the right to witness the procedures used for ascertaining that initial stringing sags and tensions are in compliance with requirements for the applicable loading district and cable weight.

3.11.6   Low-Voltage Cable Test

****

NOTE: The insulation resistance test (dielectric test) value is based on the recommendation contained in IEEE Std 525. Delete the cable test if no low voltage cables are in the project.

****

For underground secondary or service laterals from overhead lines, the low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations of conductors in the same trench, duct, or cable, with other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

Each cable failing this test shall be repaired or replaced. The repaired cable shall then be retested until failures have been eliminated.

3.11.7 Liquid-Filled Transformer Tests

The following field tests shall be performed on liquid-filled transformers [[_____] kVA and above]. Pass-fail criteria shall be in accordance with the transformer manufacturer's specifications.

a. Insulation resistance test phase-to-ground.

b. Turns ratio test.

c. Correct phase sequence.

d. [_____]

3.11.8 Pre-Energization Services

The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to insure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment and to ensure that packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services shall be provided, but are not limited to, are the following:

Automatic circuit reclosers.

Capacitors.

Switches.

Transformers.

3.11.9 Operating Tests

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

3.12 MANUFACTURER'S FIELD SERVICE

****

NOTE: Delete if not required.
****

3.12.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of [_____] hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A [_____] [BETA] [VHS] format video tape of the entire training session shall be submitted.

3.12.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

3.13 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-16375 (November 1992)**
U.S. ARMY CORPS OF ENGINEERS | **-------------------------**
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SECTION 16375

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND
11/92

****
NOTE: This guide specification covers the requirements for underground electrical distribution systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

This guide specification includes tailoring options for medium voltage, and low voltage. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in

project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.4	(1984; R 1996) Mechanical Demand Registers
ANSI C12.10	(1987) Electromechanical Watthour Meters
ANSI C12.11	(1987; R 1993) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)
ANSI C29.1	(1988; R 1996) Electrical Power Insulators - Test Methods
ANSI C37.16	(1988; C37.16a; R 1995) Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations
ANSI C37.46	(1981; R 1992) Power Fuses and Fuse Disconnecting Switches
ANSI C37.50	(1989; R 1995) Switchgear, Low-Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures
ANSI C37.72	(1987) Manually-Operated Dead-Front, Padmounted Switchgear with Load-Interrupting Switches and Separable Connectors for Alternating-Current Systems
ANSI C37.121	(1989; R 1995) Switchgear, Unit Substations Requirements
ANSI C57.12.13	(1982) Conformance Requirements for Liquid-Filled Transformers Used in Unit Installations, Including Unit Substations
ANSI C57.12.21	(1995) Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with High-Voltage Bushings; (High-Voltage, 34 500 Grd Y/19 920 Volts and Below; Low-Voltage, 240/120; 167 kVA and Smaller)
ANSI C57.12.26	(1993) Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors,

	High-Voltage, 34 500 Grd Y/19 920 Volts and Below; 2500 kVa and Smaller
ANSI C57.12.27	(1982) Conformance Requirements for Liquid-Filled Distribution Transformers Used in Pad-Mounted Installations, Including Unit Substations
ANSI C57.12.28	(1996) Switchgear and Transformers - Padmounted Equipment - Enclosure Integrity
ANSI C80.1	(1995) Rigid Steel Conduit - Zinc Coated
ANSI C119.1	(1986) Sealed Insulated Underground Connector Systems Rated 600 Volts
ANSI C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction
ANSI O5.1	(1992) Specifications and Dimensions for Wood Poles

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48	(1994a) Gray Iron Castings
ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(1995) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 3	(1995) Soft or Annealed Copper Wire
ASTM B 8	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM B 231	(1995) Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B 400	(1994) Compact Round Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B 496	(1992) Compact Round Concentric-Lay-Stranded Copper Conductors
ASTM B 609	(1997) Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes
ASTM B 609M	(1991) Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes (Metric)
ASTM B 800	(1994) 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and

	Intermediate Tempers
ASTM B 801	(1995) Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation
ASTM C 478	(1997) Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(1997) Precast Reinforced Concrete Mahhole Sections (Metric)
ASTM D 923	(1991) Sampling Electrical Insulating Liquids
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2472	(1992) Sulfur Hexafluoride
ASTM D 4059	(1996) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography
ASTM F 883	(1990) Padlocks

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS5	(1994) Cross-linked Polyethylene Insulated Shielded Power Cables Rated 5 Through 46 kV
AEIC CS6	(1996) Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825a	(1998) Approval Guide Fire Protection

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE ANSI/IEEE C37.1	(1994) IEEE Standard Definition, Specification, and Analysis of Systems Used for Supervisory Control, Data Acquisition, and Automatic Control
IEEE ANSI/IEEE C37.2	(1996) Electrical Power System Device Function Numbers and Contact Designations
IEEE ANSI/IEEE C37.13	(1990; R 1995) Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE ANSI/IEEE C37.20.1	(1993) Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
IEEE ANSI/IEEE C37.20.2	(1993; C37.20.2b) Metal-Clad and Station-Type Cubicle Switchgear

IEEE ANSI/IEEE C37.20.3	(1987; R 1992) Metal-Enclosed Interrupter Switchgear
IEEE ANSI/IEEE C37.23	(1987; R 1991) Guide for Metal-Enclosed Bus and Calculating Losses in Isolated-Phase Bus
IEEE ANSI/IEEE C37.30	(1997)Requirements for High-Voltage Switches
IEEE ANSI/IEEE C37.34	(1994) Test Code for High-Voltage Air Switches
IEEE ANSI/IEEE C37.41	(1994; C37.41e) Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories
IEEE ANSI/IEEE C37.63	(1997) Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizer for AC Systems
IEEE ANSI/IEEE C37.90	(1989; R 1994) Relays and Relay Systems Associated with Electric Power Apparatus
IEEE ANSI/IEEE C37.90.1	(1989; R 1994) IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
IEEE ANSI/IEEE C37.98	(1987; R 1990) Seismic Testing of Relays
IEEE ANSI/IEEE C57.12.00	(1993) IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE ANSI/IEEE C57.13	(1993) Instrument Transformers
IEEE ANSI/IEEE C57.98	(1993) Guide for Transformer Impulse Tests
IEEE C62.1	(1989; R 1994) Surge Arresters for AC Power Circuits
IEEE C62.2	(1987; R 1994) Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems
IEEE C62.11	(1993) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
IEEE Std 48	(1996) Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)

IEEE Std 100	(1996) IEEE Standard Dictionary of Electrical and Electronics Terms
IEEE Std 242	(1986; R 1991) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
IEEE Std 386	(1995) Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE Std 399	(1997) Recommended Practice for Industrial and Commercial Power Systems Analysis
IEEE Std 404	(1993; errata) Cable Joints for Use with Extruded Dielectric Cable Rated 5000 V through 138 000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500 V Through 500 000 V
IEEE Std 592	(1990; R 1996) Exposed Semiconducting Shields on Premolded High Voltage Cable Joints and Separable Insulated Connectors

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA BU 1	(1994) Busways
NEMA FB 1	(1993) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit and Cable Assemblies
NEMA FU 1	(1986) Low Voltage Cartridge Fuses
NEMA LA 1	(1992) Surge Arresters
NEMA PB 1	(1990) Panelboards
NEMA PB 2	(1995) Deadfront Distribution Switchboards
NEMA SG 2	(1993) High Voltage Fuses
NEMA SG 3	(1995) Power Switching Equipment
NEMA SG 5	(1990) Power Switchgear Assemblies
NEMA TC 5	(1990) Corrugated Polyolefin Coilable Plastic Utilities Duct
NEMA TC 6	(1990) PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA TC 7	(1990) Smooth-Wall Coilable Polyethylene Electrical Plastic Duct
NEMA WC 7	(1991; Rev 1)

	Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 8	(1991; Rev 1; Rev 2) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1997) Rigid Metal Conduit
UL 198C	(1986; Rev thru Feb 1998) High-Interrupting-Capacity Fuses, Current-Limiting Types
UL 198D	(1995) Class K Fuses
UL 198E	(1988; Rev Jul 1988) Class R Fuses
UL 198H	(1988; Rev thru Nov 1993) Class T Fuses
UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 486A	(1997) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1997; Rev Jun 1997) Wire Connectors for Use with Aluminum Conductors
UL 489	(1996; Rev thru Nov 1997) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 510	(1994; Rev thru Nov 1997) Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(1996; Rev Jul 1998) Metallic Outlet Boxes
UL 651	(1995; Rev thru Oct 1998) Schedule 40 and 80 Rigid PVC Conduit
UL 854	(1996; Rev Apr 1998) Service-Entrance Cables
UL 857	(1994; Rev thru Nov 1996) Busways and Associated Fittings
UL 1072	(1995; Rev Mar 1998) Medium-Voltage Power Cable

UL 1242	(1996; Rev Apr 1997) Intermediate Metal Conduit
UL 1684	(1996) Reinforced Thermosetting Resin Conduit (RTRC) and Fittings

1.2 GENERAL REQUIREMENTS

****
NOTE: Select the features and fill in blanks with selections appropriate for the design condition and in accordance with guidance contained in TM 5-811-1/AF AFJMAN 32-1080.
****

1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.

1.2.2 Service Conditions

****
NOTE: See TM 5-811-1/AF AFJMAN 32-1080 for guidance regarding service conditions. Retain or add the required conditions.

Provide seismic requirements, if a Government designer is the Engineer of Record, and show on the drawings. Delete the inappropriate bracketed phrase. Sections 13080 and 16070, properly edited, must be included in the contract documents.
****

Items provided under this section shall be specifically suitable for the following service conditions. Seismic details shall [conform to Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT] [be as indicated].

a. Fungus Control [_____]

b. Altitude [_____] feet

c. Ambient Temperature [_____] degrees F

d. Frequency [_____]

e. Ventilation [_____]

f. Seismic Parameters [_____]

g. Humidity Control [_____]

h. Corrosive Areas [_____]

i. [_____]

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

The number of copies of Operation and Maintenance Manuals, SD-19 will be the same as the quantity stated in the SPECIAL CONTRACT REQUIREMENTS. If none is specified, six copies will be required. Three additional copies will be submitted following approval, and will be provided to the Using Agency. Delete O & M manuals when not required.

Delete SD-04 if local supplemental clauses duplicate this requirement.

Delete cable installation reports for projects where cables are buried and for jobs which do not require mechanically-assisted pulls.

****

Governmental approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Fault Current and Protective Devices Coordination Studies; GA.

The study shall be submitted with protective device equipment submittals. No time extension or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed shall be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Manufacturer's Catalog Data; [_____].

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists; [_____].

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

Installation Procedures; [_____].

As a minimum, installation procedures for transformers, substations, switchgear, and medium-voltage cable terminations and splices.

Procedures shall include cable pulling plans, diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

SD-04 Drawings

Electrical Distribution System; [_____].

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams manufacturers standard installation drawings and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be included with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.

b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

Detail drawings shall as a minimum depict the installation of the following items:

a. Medium-voltage cables and accessories including cable installation plan.

b. Transformers.

c. Substations.

d. Switchgear.

e. Pad-mounted loadbreak switches.

f. Busways.

g. Surge arresters.

As-Built Drawings; [_____].

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall provide three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within 10 calendar days from the time the drawings are returned to the Contractor.

SD-09 Reports

Factory Test; [_____].

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests. The manufacturer's pass-fail criteria for tests specified in paragraph FIELD TESTING shall be included.

Field Testing; [_____].

A proposed field test plan, [20] [30] [_____] days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Test Reports; [_____].

[Six] [_____] copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The condition specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

Cable Installation Reports; [_____].

[Six] [_____] copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

a. Site layout drawing with cable pulls numerically identified.

b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.

c. The cable manufacturer and type of cable.

d. The dates of cable pulls, time of day, and ambient temperature.

e. The length of cable pull and calculated cable pulling tensions.

f. The actual cable pulling tensions encountered during pull.

SD-13 Certificates

Materials and Equipment; [_____].

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications.

Cable Splicer Qualification; [_____].

A certification that contains the names and the qualifications of people recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. The certification shall indicate that any person recommended to perform actual splicing and terminations has been adequately trained in the proper techniques and have had at least three recent years of experience in splicing and terminating the same or similar types of cables approved for installation. In addition, any person recommended by the Contractor may be required to perform a practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer of medium-voltage cables. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types.

Cable Installer Qualifications; [_____].

The Contractor shall provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. A resume shall be provided showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers.

SD-19 OPERATION AND MAINTENANCE MANUALS

Electrical Distribution System; [_____].

[Six] [_____] copies of operation and maintenance manuals, within [7] [_____] calendar days following the completion of tests and including assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

1.4   DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers and switches shall be stored in accordance with the manufacturer's requirements. Wood poles held in storage for more than 2 weeks shall be stored in accordance with ANSI O5.1. Handling of wood poles shall be in accordance with ANSI O5.1, except that pointed tools capable of producing indentations more than 1 inch in depth shall not be used. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

1.5 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the contracting officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

PART 2 PRODUCTS

2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.2 NAMEPLATES

2.2.1 General

Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates shall be made of noncorrosive metal. Equipment containing liquid dielectrics shall have the type of dielectric on the nameplate. Sectionalizer switch nameplates shall have a schematic with all switch positions shown and labeled. As a minimum, nameplates shall be provided for transformers, circuit breakers, meters, switches, and switchgear.

2.2.2 Liquid-Filled Transformer Nameplates

****
NOTE: Coordinate nameplate information with the manufacturer. Select 50 ppm for Army projects and 2 ppm for Air Force projects.
****

Power transformers shall be provided with nameplate information in accordance with IEEE ANSI/IEEE C57.12.00. Nameplates shall indicate the number of gallons and composition of liquid-dielectric, and shall be permanently marked with a statement that the transformer dielectric to be supplied is non-polychlorinated biphenyl. If transformer nameplate is not so marked, the Contractor shall furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than [50] [2] ppm PCB content in accordance with paragraph LIQUID DIELECTRICS. Certifications shall be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the [50] [2] ppm PCB content or transformers without certification will be considered as PCB insulated and will not be accepted.

2.3 CORROSION PROTECTION

2.3.1 Aluminum Materials

[Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B shall be used.] [Aluminum shall not be used.]

2.3.2 Ferrous Metal Materials

2.3.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

2.3.2.2 Equipment

****

NOTE: A 120-hour test will be specified in a noncorrosive environment and a 480-hour test will be specified in a corrosive environment.

****

Equipment and component items, including but not limited to transformer stations and ferrous metal luminaries not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand [120] [480] [_____] hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

2.3.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section 09900 PAINTING, GENERAL.

2.4 CABLES

****

NOTE: Justify selection of copper or aluminum, based upon an analysis using life-cycle, environmental, and cost factors. Refer to TM 5-811-1/AF AFJMAN 32-1080 for guidance regarding cables.

****

Cables shall be single conductor type unless otherwise indicated.

2.4.1 Medium-Voltage Cables

****

NOTE: Medium voltage cables are complex and sophisticated products that can be manufactured to have very specific properties for the installed environment. The two most commonly produced/specified medium voltage cables are Type MV

(as described in UL 1072) and underground distribution ("UD/URD"), commonly used by electrical utilities. Type MV is a type designation recognized by NFPA 70 because it is UL listed. "UD/URD" is not a recognized type designation because it is utilized primarily by electrical utilities, who are not governed by NFPA 70 and for whom a UL listed cable adds unnecessary expense. Both type MV and "UD/URD" can be specified for use in duct or direct buried. Type MV cable are typically manufactured with copper or aluminum conductors; an extruded semi-conductor conductor shield; ethylene-propylene rubber (EPR) or cross-linked polyethylene (XLP) insulation; an insulation shield consisting of extruded semi-conductor and metal tape; and a polyvinyl chloride (PVC) jacket. "UD/URD" cables are typically manufactured with copper or aluminum conductors; an extruded semi-conductor conductor shield; an insulation shield consisting of extruded semi-conductor and metal tape, or extruded semi-conductor with concentric-wound copper drain wires; cross-linked polyethylene (XLP) insulation; a concentric neutral; and a polyethylene jacket. A cable can be made from almost any combination of conductors, insulations, shields and jackets; therefore, the designer needs to specify a cable that meets the needs of the application. Utilize either Type MV or "UD/URD" in ducts, keeping in mind that the concentric neutral affects bending radius and pulling tensions, therefore limiting the maximum pull and distance between manholes. Utilize "UD" for direct buried applications. Select full ampacity concentric neutral for single-phase applications and one-third ampacity for three-phase applications.

****

2.4.1.1 General

Cable construction shall be [Type MV, conforming to NFPA 70 and UL 1072] [concentric neutral underground distribution cable conforming to AEIC CS5 and NEMA WC 7] [metallic armored cables, consisting of three-conductor, multi-conductor cables, with insulation and shielding, as specified, using [a galvanized steel] [an aluminum] interlocked tape armor and thermoplastic jacket]. Cables shall be manufactured for use in [duct] [or] [direct burial] applications [as indicated].

2.4.1.2 Ratings

Cables shall be rated for a circuit voltage [of] [5 kV] [15 kV] [25 kV] [28 kV] [35 kV] [as indicated].

2.4.1.3 Conductor Material

****

NOTE: A concentric compressed conductor has a

diameter that is 3 percent less than a regular concentric conductor. A compact conductor has a diameter that is 10 percent less than a regular concentric conductor. Specify compressed or compact conductors where necessary to limit duct fill (i.e. where new conductors are installed in existing dusts). When aluminum is exposed to water, oxidation occurs. To prevent oxidation, the conductor is filled with insulation. Add filled conductor requirement if needed.
****

Underground cables shall be [soft drawn copper complying with ASTM B 3 and ASTM B 8 for regular concentric and compressed stranding or ASTM B 496 for compact stranding] [aluminum alloy 1350, 3/4 hard minimum complying with ASTM B 609, ASTM B 609M and ASTM B 231 for regular concentric and compressed stranding or ASTM B 400 for compacted stranding].

2.4.1.4 Insulation

****
NOTE: In addition to the standard MV-90, NFPA 70 also lists an MV-105 temperature rating. However, MV-105 is not available from all manufacturers. Provide MV-105, only if needed. For projects which require multiple types of insulations, or special types of cables, such as submarine cable, indicate the type for each cable on the project drawings. Choose XLP or tree retardant XLP for "UD or URD" cable, and either XLP or EPR for Type MV cable.
****

Cable insulation shall be [cross-linked thermosetting polyethylene (XLP) insulation conforming to the requirements of NEMA WC 7 and AEIC CS5] [ethylene-propylene-rubber (EPR) insulation conforming to the requirements of NEMA WC 8 and AEIC CS6] [_____]. A 133 percent insulation level shall be used on 5 kV, 15 kV and 25 kV rated cables.

2.4.1.5 Shielding

****
NOTE: IEEE C2 requires the cable conductor shield to have sufficient ampacity to withstand the effects of available fault current without damage to the conductor (except in the vicinity of the fault). The designer should provide the expected maximum available ground fault current, so the cable manufacturer can size the shield. Testing has shown that for grounded medium voltage systems where a bare ground fault return conductor is installed with phase conductors in metallic duct, 3% - 14% of the available fault current returns along the cable shield. A separate ground fault return conductor (bare copper wire or metallic duct) should always be provided. For circuits not installed in metallic duct, with a ground fault return conductor supplied,

the shield can be sized to conduct (until the protective device operates) 15% of the available fault current per cable. Where the available fault current is unknown or cannot be determined, the designer should provide a # 2/0 AWG bare copper ground conductor and delete the ground fault ampacity statement.

****

Cables rated for 2 kV and above shall have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper [tape] [wire] shield for each phase. The shield [tape] [wire] shall be sized to meet IEEE C2 requirements for a ground fault availability of [_____] amperes.

2.4.1.6 Neutrals

****

NOTE: Where high impedance grounded neutral systems are employed, add the following requirement for the neutral to be fully insulated. For high impedance grounded neutral systems, the neutral conductors from the neutral point of the transformer or generator to the connection point at the impedance shall utilize [copper] [aluminum] conductors, employing the same insulation level and construction as the phase conductors.

****

[Neutral conductors of shall be [copper] [aluminum]. employing the same insulation and jacket materials as phase conductors, except that a 600-volt insulation rating is acceptable.] [Concentric neutrals conductors shall be tinned copper, having a combined ampacity [equal to] [1/3 of] the phase conductor ampacity rating.]

2.4.1.7 Jackets

****

NOTE: PVC is acceptable for duct applications. Polyethylene is exceptional for direct burial and in duct applications where there is significant amounts of water. There are many other types of jacket materials available (neoprene, hypalon, thermoplastic CPE) for special environments involving exposure to sunlight, petroleum products, and corrosive chemicals. Consult local cable representatives to specify the appropriate jacket for the application.

****

Cables shall be provided with a [PVC] [polyethylene] [_____] jacket. Direct buried cables shall be rated for direct burial.

2.4.2 Low-Voltage Cables

****

NOTE: Coilable plastic duct may be used as an alternative to direct burial where extra physical protection is required. For project applications which require a different insulation than those listed below, reference a Government or industry standard that the cable must meet. For projects which require multiple types of insulations, indicate the type for each cable on the project drawings. See also TM 5-811-2/AFM 88-9 Chapter 2.
****

Cables shall be rated 600 volts and shall conform to the requirements of NFPA 70, and must be UL listed for the application or meet the applicable section of either ICEA or NEMA standards.

2.4.2.1 Conductor Material

Underground cables shall be [annealed copper complying with ASTM B 3 and ASTM B 8] [Type AA-8000 aluminum conductors complying with ASTM B 800 and ASTM B 801]. Intermixing of copper and aluminum conductors is not permitted.

2.4.2.2 Insulation

Insulation must be in accordance with NFPA 70, and must be UL listed for the application or meet the applicable sections of either ICEA, or NEMA standards.

2.4.2.3 Jackets

Multiconductor cables shall have an overall [PVC] [_____] outer jacket.

2.4.2.4 Direct Buried

Single and multi-conductor cables shall of a type identified for direct burial. Service entrance cables shall conform to UL 854 for Type USE service entrance cable.

2.4.2.5 In Duct

Cables shall be single-conductor cable, in accordance with NFPA 70. [Cables in factory-installed, coilable-plastic-duct assemblies shall conform to NEMA TC 5 or NEMA TC 7].

2.5 CABLE JOINTS, TERMINATIONS, AND CONNECTORS

2.5.1 Medium-Voltage Cable Joints

Medium-voltage cable joints shall comply with IEEE Std 404 and IEEE Std 592. Medium-voltage cable terminations shall comply with IEEE Std 48. Joints shall be the standard products of a manufacturer and shall be either of the factory preformed type or of the kit type containing tapes and other required parts. Joints shall have ratings not less than the ratings of the cables on which they are installed. Splice kits may be of the heat-shrinkable type for voltages up to 15 kV, of the premolded splice and connector type, the conventional taped type, or the resin pressure-filled overcast taped type for voltages up to 35 kV; except that for voltages of 7.5 kV or less a resin pressure-filled type utilizing a plastic-tape mold is acceptable. Joints used in manholes, handholes, vaults and pull boxes shall be certified by the manufacturer for waterproof, submersible applications.

2.5.2 Medium-Voltage Separable Insulated Connectors

****

NOTE: Separable connectors shall not be used in manholes (except where necessary for reason of clearance at an airfield). Loadbreak types are rated by IEEE Std 386 up to 200 amperes. Provide test points only where the local facilities engineer indicates that it is an operational requirement. If loadbreak separable connectors are allowed as substitutes for conventional permanent splices, the Using Agency often presumes that the intent was that they could be used for "switching functions." This type of generic approach can allow unsafe configurations with inadequate space for proper hookstick operation. This substitution is prohibited.

****

Separable insulated connectors shall comply with IEEE Std 386 and IEEE Std 592 and shall be of suitable construction or standard splice kits shall be used. Separable insulated connectors are acceptable for voltages up to 35 kV. Connectors shall be of the loadbreak type as indicated, of suitable construction for the application and the type of cable connected, and shall include cable shield adaptors. Separable insulated connectors shall not be used as substitutes for conventional permanent splices. External clamping points and test points shall be provided.

2.5.3 Low-Voltage Cable Splices

Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A. Splices in conductors No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A and UL 486B. Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

2.5.4 Terminations

Terminations shall be in accordance with IEEE Std 48, Class 1 or Class 2; of the molded elastomer, wet-process porcelain, prestretched elastomer, heat-shrinkable elastomer, or taped type. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations shall be of the outdoor type, except that where installed inside outdoor equipment housings which are sealed against normal infiltration of moisture and outside air, indoor, Class 2 terminations are acceptable. Class 3 terminations are not acceptable. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, and armor.

2.5.4.1 Factory Preformed Type

****

NOTE: Specify IEEE Std 48 test in areas of heavy fog, salt air, or industrial contamination. Specify track resistant tape in high humidity areas with dust and industrial contaminants.

****

Molded elastomer, wet-process porcelain, prestretched, and heat-shrinkable terminations shall utilize factory preformed components to the maximum extent practicable rather than tape build-up. Terminations shall have basic impulse levels as required for the system voltage level. [Leakage distances shall comply with wet withstand voltage test requirements of IEEE Std 48 for the next higher Basic Insulation Level (BIL) level.] [Anti-tracking tape shall be applied over exposed insulation of preformed molded elastomer terminations].

2.5.4.2 Taped Terminations

****

NOTE: Normally, specify 317.5 mm (12-1/2 in.) for 5 kV cable, 508.0 mm (20 in.) for 15 kV cable, 635.0 mm (25 in.) for 25 kV cable, and 889.0 mm (35 in.) for 28 kV or 35 kV cable. In contaminated areas, specify next higher voltage level lengths, and 1168.4 mm (46 inches) for 28 kV or 35 kV cables.

****

Taped terminations shall use standard termination kits providing terminal connectors, field-fabricated stress cones, and rain hoods. Terminations shall be at least [12-1/2] [20][25][35][46] inches long from the end of the tapered cable jacket to the start of the terminal connector, or not less than the kit manufacturer's recommendations, whichever is greater.

2.6 CONDUIT AND DUCTS

****

NOTE: Specify thin-wall for encased burial and thick-wall for direct burial. Communication lines run elsewhere will comply with communication agency's policy.

****

[Ducts shall be single, round-bore type, with wall thickness and fittings suitable for the application.] [Duct lines shall be concrete-encased, thin-wall type.] [Duct lines shall be nonencased direct-burial, thick-wall type.] [Duct lines shall be concrete-encased, thin-wall type for duct lines between manholes and for other medium-voltage lines.] [[Low-voltage lines] [or] [Communication lines] run elsewhere may be direct-burial, thick-wall type.] [Where concrete encasement is not required, low-voltage circuits may utilize factory-installed cable in coilable plastic duct.]

2.6.1 Metallic Conduit

Intermediate metal conduit shall comply with UL 1242. Rigid galvanized steel conduit shall comply with UL 6 and ANSI C80.1. Metallic conduit fittings and outlets shall comply with UL 514A and NEMA FB 1.

2.6.2 Nonmetallic Ducts

****

NOTE: Bituminized fiber duct should be specified only for connection to existing bituminized fiber duct systems. Delete the paragraph if not required. Specify thin-wall or schedule 40 plastic duct for concrete encasement and thick-wall or schedule 40 or schedule 80 plastic duct for direct-burial and riser applications (riser bends should be metallic conduit where cables are to be pulled into ductline).

****

2.6.2.1 Bituminized Fiber Duct

UL 1684 for [Type I (Thinwall)][Type II (Thickwall)].

2.6.2.2 Concrete Encased Ducts

UL 651 Schedule 40 or NEMA TC 6 Type EB.

2.6.2.3 Direct Burial

UL 651 [Schedule 40][and][Schedule 80][as indicated], or NEMA TC 6 Type DB.

2.6.3 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 300 degrees F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

2.7 MANHOLES, HANDHOLES, AND PULLBOXES

****

NOTE: Actual strength figures may need to be adjusted to accommodate various manufacturers of glass reinforced polymer boxes.

****

Manholes, handholes, and pullboxes shall be as indicated. Strength of manholes, handholes, and pullboxes and their frames and covers shall conform to the requirements of IEEE C2. Precast-concrete manholes shall have the required strength established by ASTM C 478, ASTM C 478M. Frames and covers shall be made of gray cast iron and a machine-finished seat shall be provided to ensure a matching joint between frame and cover. Cast iron shall comply with ASTM A 48, Class 30B, minimum. Handholes for low voltage cables installed in parking lots, sidewalks, and turfed areas shall be fabricated from an aggregate consisting of sand and with continuous woven glass strands having an overall compressive strength of at least [10,000] [_____] psi and a flexural strength of at least[5,000] [_____] psi. Pullbox and handhole covers in sidewalks, and turfed areas shall be of the same material as the box. Concrete pullboxes shall consist of precast reinforced concrete boxes, extensions, bases, and covers.

2.8 POLES AND HARDWARE

****

NOTE: For new pole line construction, coordinate with CEGS-16370. Where the scope of the project is small, such as installation of one or two poles, the designer may elect to incorporate the pole and hardware paragraphs from CEGS-16370 in this section.

****

Poles and hardware shall be in accordance with Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

2.9 TRANSFORMERS, SUBSTATIONS, AND SWITCHGEAR

****

NOTE: Specify transformer phase sequence in accordance with the local practice. Delete tap setting requirement where transformers do not have primary tap requirements. Provide tap settings in accordance with load-flow and voltage drop study results. Refer to TM 5-811-1/AF AFJMAN 32-1080 for guidance.

****

Transformers, substations, and switchgear shall be of the outdoor type having the ratings and arrangements indicated. Medium-voltage ratings of cable terminations shall be [5] [15] [25] [28] [35] kV between phases for 133 percent insulation level.

2.9.1 Secondary Unit Substation

Secondary unit substations shall comply with ANSI C37.121 and shall be of the [radial type] [radial type with an outgoing section mounted integrally on the transformer] [secondary-selective type] [distributed-network type] [spot-network type]. Substations shall be subassembled and coordinated by one manufacturer and shall be shipped in complete sections ready for connection at the site. Complete sections shall include incoming, transformer, and outgoing sections and, where practicable, shall be shipped as one unit.

2.9.1.1 Incoming Section

****

Note: For normal reliability systems, the primary distribution will be radial, and the incoming section will be a single metal-enclosed, fused,

load-interrupter switch. Where greater reliability is required and there are two incoming primary feeders, a selector switch or a duplex switch will be specified.

A selector switch contains a non-loadbreak incoming-line selector switch unit in series with a separate interrupter unit. The interrupter unit must be open before the selector unit may be changed; the entire metal-enclosed switch assembly is contained in one vertical section of switchgear. A duplex switch contains 2 fully rated interrupter switches connected together at their load side, and requires 2 vertical sections of switchgear.

At installations where space is very tight, the selector switch should be specified, otherwise the duplex switch is preferable and should be specified.

Voltage ratings are listed in IEEE ANSI/IEEE C37.20.3, Table 1. See TM 5-811-1/AF AFJMAN 32-1080 for guidance. Specify current ratings based upon short-circuit study.

Delete reference to SF6 insulating dielectric when not required.
****

Metal-enclosed interrupter switchgear consisting of fused, [air-insulated] [vacuum-insulated] [SF6-insulated], interrupters in series with automatic, visible blade disconnects shall be provided for protection of incoming circuits. [SF6 gas shall conform to ASTM D 2472]. Metal-enclosed interrupter switchgear shall comply with IEEE ANSI/IEEE C37.30 for load-interrupter switches, NEMA SG 2 for power fuses, and shall be of the outdoor no-aisle type that meets or exceeds the requirements of applicable publications listed. Switch construction shall be of the manually-operated, "OPEN-CLOSED," [air-insulated][vacuum-insulated][SF6-insulated], load interrupter type equipped with a stored energy operator for quick-make quick-break to make operating speeds independent of manual switch operations. Where indicated, suitable bus or lug connections shall be provided to mount field-installed, slip-on, medium-voltage cable terminations for cable entering via conduit from below [and a flanged throat suitable for direct connection to the associated transformer] [and a bus throat suitable for connection to the associated metal-enclosed bus]. [Surge protection shall be provided in accordance with paragraph SURGE ARRESTERS.] [Switches shall be of the 2-position type, open-closed.] [Selector switches shall be of the single-compartment, 3-position type, Line 1 - Open - Line 2, consisting of an interrupter switch in series with a selector switch.] [Duplex switches shall be of the dual compartment type with 2 interrupter switches.]

a. Ratings. Fuse continuous current ratings shall be as indicated for the transformer for an incoming line unit and for the line tie unit. Unless otherwise indicated, fuses shall be of the current limiting type. Switch ratings at 60 Hz shall be:

Nominal voltage..[_____].

Rated maximum voltage.......................................[_____].

Maximum symmetrical interrupting capacity..................[_____].

Maximum asymmetrical interrupting capacity.................[_____].

3-Second short time current carrying capacity..............[_____].

Rated continuous current...................................[_____].

BIL..[_____].

b. Basic Requirements. The electrical devices listed below shall be rated for the application and voltage and current indicated. Unless otherwise noted, manufacturer's standard devices shall be provided and shall include the following:

(1) A switch-operating handle with provisions for locking in either the open or closed position.

(2) A switch mechanical position indicator.

(3) A heater continuously energized to prevent condensation over an ambient temperature range of [minus [20][_____] degrees F] to [[40][_____] degrees F] at 90% relative humidity and wired in series with a cabinet door-actuated switch, so the heater is de-energized when doors are open. High-temperature thermal protection shall be included.

(4) One-pole or 2-pole thermal-magnetic, molded-case circuit breakers suitable for the operating voltage for heater circuits.

(5) Safety devices as necessary to ensure that the load interrupter switch is in the open position whenever unit doors are in the open position.

(6) A key interlock if indicated.

(7) An interface terminal block wired for required exterior connections.

2.9.1.2 Transformer Section

****

NOTE: Refer to TM 5-811-1/AF AFJMAN 32-1080 for guidance. Delete alarm contacts when not required

****

Transformers shall have two separate windings per phase and shall be of the [mineral oil-insulated] [less-flammable, liquid-insulated] type with [high molecular-weight hydrocarbon] [or] [dimethyl silicone] liquid. Transformers shall be suitable for outdoor use. Liquid-insulated transformers shall comply with IEEE ANSI/IEEE C57.12.00, ANSI C57.12.13, and ANSI C57.12.27, and shall have two 2-1/2 percent full capacity taps above and two 2-1/2 percent full capacity taps below rated voltage. Transformers shall be of the sealed tank type construction with welded-on cover. High-voltage terminals shall be provided [in an air terminal chamber for incoming [top] [bottom] entry cables][for direct connection to the incoming line section] [as shown on the drawings]. Low-voltage terminals shall be provided [in an air terminal chamber for incoming [top] [bottom] entry cables] [for direct connection to the outgoing [switchgear section] [bus duct]] [as shown on the drawings]. Low-voltage terminals shall be [on the [left] [right]] [as shown on the drawings] when facing the front, accessory side of the transformer. [Transformers shall be equipped with forced air cooling equipment to give [_____] kVA capacity. The equipment shall include the necessary fans, conduit and wiring, motor starters, and top liquid thermometer for fan control.] [Provision shall be made for the future addition of forced air cooling equipment to give [_____] kVA capacity. The transformer bushings, leads, and other components shall be designed to carry the increased load. A top liquid thermometer for control of future fans shall be furnished. Provision for future mounting of fans, conduit, and terminal box shall be provided.] Transformer accessories and ratings at 60 Hz shall be as follows:

Three-phase capacity, self-cooled.....................[_____] kVA.

Three-phase capacity, (future) forced-cooled..........[_____] kVA.

Impedance..[5.75 percent, standard] [[_____] percent nonstandard].

Temperature rise.................[65 degrees C] [55/65 degrees C].

High-voltage winding................................[_____] volts.

High-voltage winding connection...........................[_____].

Low-voltage winding.................................[_____] volts.

Low-voltage winding connection............................[_____].

Accessories:

a. drain and filter connection.

b. filling and top filter press connection.

c. pressure-vacuum gauge.

d. dial type thermometer with alarm contacts.

e. magnetic liquid level indicator with high and low level alarm contacts.

f. pressure relief device with alarm contacts.

g. ground connection pad.

h. provision for jacking, lifting, and towing.

i. diagram and rating nameplate.

2.9.1.3 Integral Outgoing Section

****

NOTE: In Unit Substation construction consisting of a transformer and low-voltage equipment, the low-voltage section must be integral or mechanically

connected with the transformer and must be a busway throat compartment; an integral, dead-front, distribution switchboard/panelboard compartment; or a group of low-voltage, metal-enclosed switchgear. For comparison, nonintegral substation construction consists of free-standing elements (primary switch/transformer/secondary protection) connected by cables. Specify cable compartments when free-standing elements (nonintegral substation construction) are used.

Specify a busway throat compartment and associated busway when the low voltage switchboard or switchgear must be located remote from the transformer and a compact, high ampacity connection is required.

Specify an integral, dead-front, distribution switchboard (typically front and rear accessible, with instruments, for larger installations) or panelboard (typically front accessible only, for smaller installations) when stationary-mounted, nondrawout, molded case circuit breakers are required and the number of feeders/branches requires only one or two panels.

Specify a mechanical, bus-bar-throat connection to a group of low voltage switchgear when large, high capacity, drawout type, low voltage power circuit breakers are required.

Specify individual watthour demand meters for transformers rated 750 kVA and above.

Specify ground fault protection only when required by NFPA 70. See TM 5-811-14 for guidance on GFP devices with double-ended substations.

Incorporate the low-voltage power circuit breaker paragraphs from CEGS-16475 if CEGS-16475 is not part of the project specifications. Delete appropriate paragraphs of this section if 16475 is included.
****

Integral outgoing section shall be of the [busway throat compartment] [dead-front distribution panelboard/switchboard] [metal-enclosed switchgear] type. Each circuit breaker and auxiliary compartment shall have a suitable metal or laminated plastic nameplate with white cut letters at least 1/4 inch high on contrasting backgrounds [identifying the breaker unit and/or circuit number] [as shown on the drawings].

a. Busway Throat Compartment Type: Outgoing section shall consist of an enclosure containing metering devices on the main secondary circuit and connections from transformer terminals to suitable busway throats provided for connections to busway installations entering [from above] [as shown]. Connection to porcelain bushings shall be made with flexible jumpers.

b. Dead-Front Distribution Panelboard/Switchboard Type: Outgoing section shall be of the panelboard/switchboard type mounted integrally with the transformer and shall consist of metering devices and main and branch circuit breakers mounted in panelboard/switchboard enclosures. Panelboards shall comply with NEMA PB 1. Switchboards shall comply with NEMA PB 2. Molded-case and low-voltage power circuit breakers shall comply with paragraph METERING AND PROTECTIVE DEVICES. Plug-in type circuit breakers are not acceptable. Directories to indicate loads served by each circuit shall be typed and mounted in holders provided on panelboard doors behind protective coverings.

c. Metal-Enclosed Switchgear Type: [Outgoing section shall be of the metal-enclosed drawout circuit breaker type, in accordance with IEEE ANSI/IEEE C37.20.1 and NEMA SG 5.] Low-voltage power circuit breakers shall comply with the requirements of paragraph METERING AND PROTECTIVE DEVICES.

d. Metering: The main secondary bus of each outgoing section assembly shall include a watthour demand meter with the necessary instrument transformers, and VT and CT test blocks. Metering shall be as specified in paragraph METERING AND PROTECTIVE DEVICES.

e. Ground Fault Protection: Ground fault protection shall be provided utilizing sensors of the zero-sequence type or by the residual connection of phase and neutral current sensors. Ground fault settings shall be [as shown] [as determined by the coordination study].

2.9.1.4 Nonintegral (Cable Compartment) Outgoing Section

****

NOTE: Specify cable compartment outgoing section when the transformer will feed the nonintegral low-voltage panelboard/switchboard/switchgear via cables. The cable compartment is actually integral to the transformer, but by using cables, the substation is classified as "nonintegral."

****

A cable compartment shall be provided on the transformer for cable connections as shown. Clamp type terminations for cables entering from [below] [above] shall be provided for connection to the transformer bushings. Clamp type cable terminations, suitable for [copper] [aluminum] conductors, shall be provided [for the circuit sizes shown] [to match circuit breakers].

2.9.2 Pad-Mounted Transformers

****

NOTE: See TM 5-811-1/AF AFJMAN 32-1080 for guidance.

****

Pad-mounted transformers shall comply with ANSI C57.12.26 and shall be of the [radial] [loop feed] type. Pad-mounted transformer stations shall be assembled and coordinated by one manufacturer and each transformer station shall be shipped as a complete unit so that field installation requirements are limited to mounting each unit on a concrete pad and connecting it to primary and secondary lines. Stainless steel pins and hinges shall be provided. Barriers shall be provided between high- and low-voltage compartments. High-voltage compartment doors shall be interlocked with low-voltage compartment doors to prevent access to any high-voltage section unless its associated low-voltage section door has first been opened. Compartments shall be sized to meet the specific dimensional requirements of ANSI C57.12.26. Pentahead locking bolts shall be provided with provisions for a padlock.

2.9.2.1 High-Voltage Compartments

****

NOTE: Select transformer fuse type and characteristics to provide protection of the transformer and coordination with upstream protective devices.

There are two types of fuses utilized in deadfront, pad-mounted transformer protection: expulsion-type, and current-limiting type. Expulsion-type fuses contain a fuse link that melts when subjected to either overload or fault current. The fuse-holding device operates such that the arc of the melting fuse link is extinguished under the transformer insulating dielectric (oil-immersed applications). Current limiting fuses create a physical circuit gap by the melting of the fuse. The opening arc is extinguished by the gases created by melting of the fuse element (drywell applications).

Fuse mounting configurations for deadfront pad-mounted transformers include: drywell mounting, where a canister is provided in the transformer tank (separated and sealed from the insulating dielectric); and "oil-immersed bayonet" mounting, where the fuse holder is mounted through the wall of the transformer tank, such that the fuse element is immersed in the transformer dielectric.

Drawout, dry-well mounted, current-limiting fuses are significantly more expensive than expulsion-type fuses and have more limited voltage- and current range operating characteristics. When specifying this fuse type, care must be exercised to ensure coordination with upstream protective devices. Although they operate on a more limited voltage range than other fuses, they are the preferred fuse type because the current limiting characteristics provides enhanced fault protection for the transformer.

Oil-immersed, bayonet-type, current limiting fuses and oil-immersed, bayonet type, overload fuses in

series with a partial range current-limiting fuse, may be preferable to the drawout, drywell mounted, current-limiting fuse because of the operating characteristics, relative cost, and off-the-shelf availability. Oil-immersed fuse operation can contaminate the transformer oil, although numerous fuse operations are required (on the order of 100) before the contamination is significant.

Delete faulted circuit indicators unless required by the operating installation.
****

The high-voltage compartment shall be dead-front construction. Primary switching and protective devices shall include loadbreak switching, [drawout, dry-well-mounted, current-limiting fuses] [oil-immersed, current-limiting, bayonet-type fuses] [oil-immersed, bayonet-type, overload fuse in series with a partial range current-limiting fuse], medium-voltage separable loadbreak connectors, universal bushing wells and inserts or integral one piece bushings and surge arresters. Fuses shall comply with the requirements of paragraph METERING AND PROTECTIVE DEVICES. The switch shall be mounted inside transformer tank with switch operating handle located in high-voltage compartment and equipped with metal loop for hook stick operation. Fuses shall be interlocked with switches so that fuses can be removed only when the associated switch is in the "OPEN" position. Adjacent to medium-voltage cable connections, a nameplate or equivalent stencilled inscription shall be provided inscribed "DO NOT OPEN CABLE CONNECTORS UNLESS SWITCH IS OPEN." Surge arresters shall be fully insulated and configured to terminate on [the same bushing as the primary cable by means of a loadbreak, feed-through bushing insert] [a second set of high voltage bushings].

2.9.2.2 Load-Break Switch

****
NOTE: Choose one of the following options.
****

[Radial-feed oil-immersed type rated at [15] [_____] kV, [95] [_____] kV BIL, with a continuous current rating and load-break rating of [200] [_____] ampere, and a make-and-latch rating of 10,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment.]

[Loop feed sectionalizer switches: Provide three, two-position, oil-immersed type switches to permit closed transition loop feed and sectionalizing. Each switch shall be rated at [15] [_____] kV, [95] [_____] kV BIL, with a continuous current rating and load-break rating of [200] [_____] amperes, and a make-and-latch rating of 10,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment.] Operation of switches shall be as follows:

ARRANGEMENT #	DESCRIPTION OF SWITCH ARRANGEMENT	SWITCH POSITION LINE A SW OPEN	LINE A SW CLOSE	LINE B SW OPEN	LINE B SW CLOSE	XFMR SW OPEN	XFMR SW CLOSE
1	Line A connected to Line B and both lines connected to		X		X		X

ARRANGEMENT #	DESCRIPTION OF SWITCH ARRANGEMENT transformer	SWITCH POSITION LINE A SW OPEN	LINE A SW CLOSE	LINE B SW OPEN	LINE B SW CLOSE	XFMR SW OPEN	XFMR SW CLOSE
2	Transformer connected to Line A only		X	X			X
3	Transformer connected to Line B only	X			X		X
4	Transformer open and loop closed		X		X	X	
5	Transformer open and loop open	X		X		X	

2.9.2.3 Transformer Tank Sections

****

NOTE: For 480Y/277 volt secondaries, 2 primary taps above and 2 primary taps below are standard. For 208Y/120 volt secondaries, 4 primary taps below are standard. Normally, the design should use standard impedances in conjunction with circuit breakers having adequate interrupting ratings. ANSI C57.12.26, Table 2, lists 5.75 percent for 750 kVA - 2500 kVA. For 75 kVA - 500 kVA, use manufacturer's standard.

****

Transformers shall comply with IEEE ANSI/IEEE C57.12.00, ANSI C57.12.21, and ANSI C57.12.26 and shall be of the [mineral oil-insulated type] [less-flammable, liquid-insulated type with [high molecular-weight hydrocarbon] [or] [dimethyl silicone] liquid]. Transformers shall be suitable for outdoor use and shall have 2 separate windings per phase. Standard NEMA primary taps shall be provided. Where primary taps are not specified, 4, 2-1/2 percent rated kVA high-voltage taps shall be provided [2 above and 2 below] [below] rated, primary voltage. Operating handles for primary tap changers for de-energized operation shall be located within high-voltage compartments, externally to transformer tanks. Adjacent to the tap changer operating handle, a nameplate or equivalent stenciled inscription shall be provided and inscribed "DO NOT OPERATE UNDER LOAD." Transformer ratings at 60 Hz shall be as follows:

Three-phase capacity.....................................[_____] kVA.

Impedance..[_____].

Temperature Rise..65 degrees C.

High-voltage winding....................................[_____] volts.

High-voltage winding connections............................[_____].

Low-voltage winding...................................[_____] volts.

Low-voltage winding connections................. .... [_____]

2.9.2.4   Low-Voltage Cable Compartments

Neutrals shall be provided with fully-insulated bushings. Clamp type cable terminations, suitable for [copper] [aluminum] conductors entering from below, shall be provided as necessary.

2.9.2.5   Accessories

****

NOTE: Specify thermometer, liquid level gauge, and a sampling device only where requested by the Using Agency.

****

High-voltage warning signs shall be permanently attached to each side of transformer stations. Voltage warning signs shall comply with IEEE C2. Copper-faced steel or stainless steel ground connection pads shall be provided in both the high- and low-voltage compartments. Dial-type thermometer, liquid-level gauge, and drain valve with built-in sampling device shall be provided for each transformer station. Insulated-bushing-type parking stands shall be provided adjacent to each separable load-break elbow to provide for cable isolation during sectionalizing operations.

2.9.3   Busways

Busways shall comply with NEMA BU 1 and UL 857 and shall be of the voltage, phase, and continuous current ratings indicated. Neutrals shall be [full size] [half size]. Busways shall have short-circuit ratings not less than the maximum short-circuit currents of associated transformers, assuming primary sources of infinite capacity. Busways shall be feeder-low-impedance type and of outdoor or indoor service construction as suitable to the location. Busways shall be complete with elbows, fittings, flanges, end-closures, tees, crosses, cable-tap boxes, accessories, and other devices required for the indicated installation, and shall be coordinated for connection to the indicated equipment. For wet/damp locations, bus duct shall be heated, nonventilated enclosure, nonsegregated phase type in accordance with IEEE ANSI/IEEE C37.23. Detail drawings for busway supports and bracing shall be submitted in accordance with the detail drawings portion of paragraph SUBMITTALS and shall indicate that busways are adequately supported for the seismic forces specified in paragraph GENERAL REQUIREMENTS (sub-paragraph Service Conditions).

2.9.4   Pad-Mounted, Metal-Enclosed, Switchgear

The switchgear shall be configured with [[2] [_____] incoming compartments for loop-feed arrangement] [one incoming compartment for radial-feed], equipped with [air-insulated, load-interrupter switches] [oil-insulated, load-interrupter switches] [SF6-insulated, load-interrupter switches], as indicated. The outgoing compartments shall be provided with [fused disconnects] [non-reclosing vacuum-type interrupters or circuit breakers], as indicated.

2.9.4.1 Ratings at 60 Hz shall be:

Nominal voltage (kV).......................................[_____].

Rated maximum voltage (kV).................................[_____].

Rated continuous current (A)...............................[_____].

Maximum symmetrical interrupting capacity (kA).............[_____].

Maximum asymmetrical interrupting capacity (kA)............[_____].

Three-second short-time current-carrying capacity (kA)......[_____].

BIL (kV)...[_____].

2.9.4.2 Operators, Devices, and Controls

Operators and controls shall be provided for the switchgear as follows:

a. Switches shall be provided with a manual, handle-type operator or a push-button mechanical spring tripping mechanism, utilizing a stored-energy (spring-driven) mechanism to simultaneously open or close all phases. The switchgear shall be configured so that the switch actuator is padlockable, but may be accessed without opening the switch compartment doors.

b. Fused disconnects shall be hook-stick operated.

c. Switches shall be provided with an automatic switch operator configured for local and remote opening and closing. An actuator charging motor shall be provide which operates at [12 V dc], [24 V dc] [120 V ac]. Switches shall be provided with remote telemetry units (RTUs) for remote operation and integration with supervisory, control, and data acquisition systems. Systems, components, and equipment shall conform to the requirements and recommendations of IEEE ANSI/IEEE C37.1.

d. Vacuum type interrupters shall be provided with an electronic controller for trip initiation. Manual trip initiation shall be provided by a push button or switch. Automatic trip shall be initiated by detection of excessive current. The electronic controller shall provide trip current selection capability according to present time-current response curves, as indicated. Each interrupter shall be provided with a 3 phase, gang-operated handle mechanism for trip and reset.

2.9.4.3 Enclosures

Switchgear enclosures shall be of freestanding, self-supporting construction provided with separate incoming and outgoing compartments configured for bottom cable entry. Enclosures shall be of deadfront construction, provided with a hinged door for access to each compartment, and conform to the requirements of ANSI C57.12.28, ANSI C37.72, and IEEE ANSI/IEEE C37.20.3, Category A.

2.9.5 Pad-Mounted Sectionalizers

****
NOTE: Sectionalizer operation must be coordinated with substation recloser operating characteristics.
****

Pad-mounted, sectionalizing switches shall conform to the requirements of IEEE ANSI/IEEE C37.63. The switchgear shall be configured with [[2] [_____] incoming compartments for loop-feed arrangement] [one incoming compartment for radial-feed] equipped with [air-insulated, load-interrupter switches] [oil-insulated, load-interrupters switches] [SF6-insulated load-interrupter switches], as indicated. The outgoing compartments shall be provided with non-reclosing sectionalizers.

2.9.5.1 Ratings

Ratings at 60 Hz shall be:

Nominal voltage (kV)..[_____].

Rated maximum voltage (kV)......................................[_____].

Rated continuous current (A)....................................[_____].

Three-second short-time current-carrying capacity (kA)...........[_____].

BIL (kV)..[_____].

2.9.5.2 Enclosures

Switchgear enclosures shall be of freestanding, self-supporting construction provided with separate incoming and outgoing compartments configured for bottom cable entry. Enclosures shall be of deadfront construction, provided with a hinged door for access to each compartment, and conform to the requirements of ANSI C57.12.28, ANSI C37.72, and IEEE ANSI/IEEE C37.20.3, Category A.

2.9.6 Cable Terminating Cabinets

****
NOTE: Cable terminating cabinets may be used for above ground applications only. They may be utilized in place of manholes for cable splicing where the local water table does not allow for manhole drainage, or in limited applications where it is desirable to provide a dead-break circuit sectionalizing point for circuit isolation. Loadbreak connectors are not available for applications above 200 A.
****

Cable terminating cabinets shall be hook-stick operable, deadfront construction conforming to the requirements of IEEE ANSI/IEEE C37.20.3, Category A. Cabinets shall be provided with [with 200 A. loadbreak junctions and elbow-type separable loadbreak connectors, cable parking stands, and grounding lugs] [with 600 A. dead-break junctions and elbow-type separable dead-break connectors, cable parking stands, and grounding lugs]. The cable terminating equipments shall conform to IEEE

Std 386.

Ratings at 60 Hz shall be:

Nominal voltage (kV)..[_____].

Rated maximum voltage (kV)......................................[_____].

Rated continuous current (A)....................................[_____].

Three-second short-time current-carrying capacity (kA)..........[_____].

BIL (kV)..[_____].

2.10 METERING AND PROTECTIVE DEVICES

2.10.1 Circuit Breakers, Low-Voltage

2.10.1.1 Low-Voltage Power Circuit Breakers

a. Construction

Low-voltage power circuit breakers shall conform to IEEE ANSI/IEEE C37.13, ANSI C37.16, and NEMA SG 3 and shall be three-pole, single-throw, stored energy, [manually] [electrically] operated, with drawout mounting. Solid-state trip elements which require no external power connections shall be provided. Circuit breakers shall have an open/close contact indicator, primary disconnect devices, and a mechanical interlock to prevent making or breaking contact of primary disconnections when the circuit breaker is closed. Control voltage shall be [[24] [48] [125] V dc] [120 V ac] [as indicated]. The circuit breaker enclosure shall be suitable for its intended location.

b. Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Circuit breakers shall be rated for 100 percent continuous duty and shall have trip current ratings and frame sizes as shown. Nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings shall be in accordance with ANSI C37.16. Tripping features shall be as follows:

1. Long-time current pick-up, adjustable from 50 percent to 100 percent of sensor current rating.

2. Adjustable long-time delay.

3. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.

4. Adjustable short-time delay.

5. [Short-time I2t switch.]

6. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.

7. Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes.

Sensing of ground-fault current at the main bonding jumper or ground strap shall not be permitted. [Zone-selective interlocking shall be provided as shown.]

8. [Fixed] [Adjustable] ground-fault delay.

9. [Ground-fault I2t switch.]

10. [Overload] [and] [short-circuit] [and] [ground-fault] trip indicators shall be provided.

2.10.1.2 Molded-Case Circuit Breakers

****

NOTE: See CEGS-16415 for specific requirements for molded-case circuit breakers. Add appropriate portions of 16415 as needed to meet project requirements.

****

NEMA AB 1 and UL 489.

2.10.2 Fuses, Medium-Voltage, Including Current-Limiting

2.10.2.1 Construction

Units shall be suitable for outdoor use. Fuses shall have integral blown-fuse indicators. All ratings shall be clearly visible.

2.10.2.2 Ratings

[Expulsion-type] [Current-limiting] power fuses shall have ratings in accordance with ANSI C37.46 and as follows:

Nominal voltage...[_____].

Rated maximum voltage...[_____].

Maximum symmetrical interrupting capacity.......................[_____].

Rated continuous current..[_____].

BIL...[_____].

2.10.2.3 E-Rated, Current-Limiting Power Fuses

E-rated, current-limiting, power fuses shall conform to ANSI C37.46.

2.10.2.4 C-Rated, Current-Limiting Power Fuses

C-rated, current-limiting power fuses shall open in 1000 seconds at currents between 170 and 240 percent of the C rating.

2.10.3 Fuses, Low-Voltage, Including Current-Limiting

Low-voltage fuses shall conform to NEMA FU 1. Time delay and nontime delay options shall be as [shown] [specified]. Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilizes fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination.

2.10.3.1 Cartridge Fuses

****

NOTE: Class RK1 provides high current limitation with both time-delay and nontime-delay. RK5 provides moderate current limitation, time-delay option.

****

Cartridge fuses, current-limiting type, Class [G] [J] [K] [L] [RK1] [RK5] [RK9] [T] [CC] shall have tested interrupting capacity not less than [100,000] [200,000] amperes. Fuse holders shall be the type that will reject Class H fuses.

a. Class [G] [J] [L] [CC] fuses shall conform to UL 198C.

b. Class K fuses shall conform to UL 198D.

c. Class R fuses shall conform to UL 198E.

d. Class T fuses shall conform to UL 198H.

2.10.3.2 Transformer Circuit Fuses

Transformer circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

2.10.4 Instrument Transformers

2.10.4.1 General

Instrument transformers shall comply with ANSI C12.11 and IEEE ANSI/IEEE C57.13. Instrument transformers shall be configured for mounting in/on the device to which they are applied. Polarity marks on instrument transformers shall be visually evident and shown on drawings.

2.10.4.2 Current Transformers

****

NOTE: See TM 5-811-1/AF AFJMAN 32-1080 regarding guidance on current transformers. Accuracy class ratings of current transformers (CTs) at standard burdens are listed in IEEE ANSI/IEEE C57.13. The minimum standard current transformer accuracies for metal-clad switchgear are listed in ANSI C37.20.2. In general, ANSI C12.11 requires a 0.3 accuracy class for up to a B-0.5 burden, except for some 200 and 400 ampere units. Where metering current transformers are provided, this accuracy class should be specified, if available for the ampere rating and burden needed. A "C" classification

means the ratio error can be calculated, whereas a "T" classification is one which has to be derived by testing. IEEE ANSI/IEEE C37.20.2 permits either classification up to the indicated ratings.
****

Unless otherwise indicated, bar, wound, or window-type transformers are acceptable; and except for window-type units installed over insulated buses, transformers shall have a BIL rating consistent with the rated BIL of the associated switchgear or electric power apparatus bushings, buses or conductors. Current transformers shall have the indicated ratios. The continuous thermal-current rating factor shall not be less than [1.0] [1.2] [1.5] [2.0] [3.0] [4.0]. Other thermal and mechanical ratings of current transformers and their primary leads shall be coordinated with the design of the circuit breaker and shall be not less than the momentary rating of the associated circuit breaker. Circuit protectors shall be provided across secondary leads of the current transformers to prevent the accident open-circuiting of the transformers while energized. Each terminal of each current transformer shall be connected to a short-circuiting terminal block in the circuit interrupting mechanism cabinet, power transformer terminal cabinet, and in the associated instrument and relay cabinets.

2.10.4.3   Current Transformers for Power Transformers

****
NOTE: ANSI C57.12.10, Table 20 gives recommended values.
****

[Single-ratio] [Multi-ratio] bushing type current transformers shall be provided internally around power transformer bushings as shown. [Single-ratio units shall have a minimum relaying accuracy class of [0.6B-0.5] [0.3B-0.5].] [Multi-ratio units shall have a minimum relaying accuracy voltage class of [_____] for either a C or T classification.]

2.10.4.4   Current Transformers for Metal-Enclosed Switchgear

Single-ratio units, used for metering and relaying, shall have a metering accuracy class rating of [_____] [B._____]. Single-ratio units, used only for relaying, shall have a relaying accuracy class rating of [_____] for [either] a C [or T] classification.

2.10.4.5   Current Transformers for Kwh and Demand Metering (Low-Voltage)

****
NOTE: Use the following guidelines for specifying current transformers.

1. Select the standard current transformer (CT) primary rating which is just below the full load current of the serving power transformer, i.e., for a 500 kVA transformer with a full load of 1387 amps at 208 volts-select a 1200/5 CT ratio; for a 750 kVA transformer with a full load of 902 amps at 480 volts-select a 800/5 CT ratio.

2. Select a continuous-thermal-current rating

factor (RF) in accordance with the following Table:

RATIO	**RF at 30 degrees C**
200/5	**4.0**
300/5	**3.0**
400/5	**4.0**
600/5	**3.0**
800/5	**2.0**
1200/5	**1.5**
1500/5	**1.5**
2000/5	**1.5**
3000/5	**1.33**

3. Select an ANSI Metering Accuracy Class in accordance with the following Table:

Primary Amp Rating (of CT)	**Accuracy Class**
200	**0.3 thru B-0.1**
300-400	**0.3 thru B-0.2**
600-1200	**0.3 thru B-0.5**
1500	**0.3 thru B-0.9**
2000-3000	**0.3 thru B-1.8**

****

Current transformers shall conform to IEEE ANSI/IEEE C57.13. Provide current transformers with a metering accuracy Class of 0.3 through [_____], with a minimum RF of [_____] at 30 degrees C, with 600-volt insulations, and 10 kV BIL. Provide butyl-molded, window-type current transformers mounted [on the transformer low-voltage bushings. Route current transformer leads in a location as remote as possible from the power transformer secondary cables to permit current measurements to be taken with hook-on-ammeters.] [in the current transformer cabinet.]

2.10.4.6 Voltage Transformers

****

NOTE: See TM 5-811-1/AF AFJMAN 32-1080 for guidance regarding voltage transformers. Minimum standard potential transformer accuracies for metal-clad switchgear are not listed in IEEE ANSI/IEEE C37.20.2. Accuracy classes as listed in IEEE ANSI/IEEE C57.13 are 0.3, 0.6, and 1.2. Standard burdens for each accuracy class are W, X, Y, ZZ, and M. The designer should check the burdens connected to determine the actual accuracy class and burden required. In general, ANSI C12.11 requires 0.3 accuracy class for up to Y burdens, except for voltages of 5 kV and below. Where metering potential transformers are provided, a 0.3 accuracy class should be specified, if available for the voltage rating and burden needed.

****

Voltage transformers shall have indicated ratios. Units shall have an accuracy class rating of [_____]. Voltage transformers shall be of the drawout type having current-limiting fuses in both primary and secondary circuits. Mechanical interlocks shall prevent removal of fuses, unless the associated voltage transformer is in a drawout position. Voltage transformer compartments shall have hinged doors.

2.10.5 Watthour Meters

****

NOTE: Coordinate demand interval with local utility. Coordinate devices with EMCS equipment. For small, non-critical installations, residential-type watthour meters may be adequate. Revise paragraph as required.

****

Watthour meters shall conform to ANSI C12.10, except numbered terminal wiring sequence and case size may be the manufacturer's standard. Watthour meters shall be of the [drawout switchboard type] [socket mounted [outdoor] [indoor] type] having a [15] [30] [60] [_____] minute, cumulative form, demand register meeting ANSI C12.4 and provided with not less than 2-1/2 stators. [Watthour demand meters shall have factory-installed electronic pulse initiators. Pulse initiators shall be solid-state devices incorporating light-emitting diodes, phototransistors, and power transistors, except that mercury-wetted output contacts are acceptable. Initiators shall be totally contained within watthour demand meter enclosures, shall be capable of operating up to speeds of 500 pulses per minute with no false pulses, and shall require no field adjustments. Initiators shall be calibrated for a pulse rate output of 1 pulse per 1/4 disc revolution of the associated meter and shall be compatible with the indicated equipment].

2.10.6 Protective Relaying

****

NOTE: Ranges selected will be based on the coordination study. Refer to TM 5-811-1/AF AFJMAN 32-1080 and TM 5-811-14 for guidance regarding protective relays.

****

2.10.6.1 General

[Solid-state] [Microprocessor-based] protective relays shall be provided as shown and shall be of a type specifically designed for use on power switchgear or associated electric power apparatus. Protective relays shall conform to IEEE ANSI/IEEE C37.90. Relays and auxiliaries shall be suitable for operation with the instrument transformer ratios and connections provided.

2.10.6.2 Construction

Relays shall be dustproof and moisture resistant. Necessary test devices shall be incorporated within each relay and shall provide a means for testing either from an external source of electric power or from associated instrument transformers. Each relay shall be provided with an operation indicator and an external target reset device. Relays shall have necessary auxiliaries for proper operation. Relays and auxiliaries shall be suitable for operation with the instrument transformer ratios and connections provided.

2.10.6.3 Ratings

Relays shall be the manufacturer's standard items of equipment with appropriate ranges for time dial, tap, and other settings. Relay device numbers shall correspond to the function names and descriptions of IEEE ANSI/IEEE C37.2.

2.11 SURGE ARRESTERS

****

NOTE: Surge arresters should be located at both the riser pole and at the equipment. Dead front transformer primary compartments may require special provisions to accommodate the arresters.

****

Surge arresters shall comply with NEMA LA 1, IEEE C62.1, IEEE C62.2, and IEEE C62.11 and shall be provided where indicated. Arresters shall be [station] [intermediate] [distribution] class, rated as shown. Arresters for use at elevations in excess of 6000 feet above mean sea level shall be specifically rated for that purpose. Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be of the [valve] [or] [metal-oxide varistor] [or] [combination valve-metal-oxide varistor] type.

2.12 GROUNDING AND BONDING

2.12.1 Driven Ground Rods

Ground rods shall be [copper-clad steel conforming to UL 467] [zinc-coated steel conforming to ANSI C135.30] [solid stainless steel] not less than [5/8 inch][3/4 inch] in diameter by [10 feet][8 feet] in length. Sectional type rods may be used.

2.12.2 Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

2.13 CONCRETE AND REINFORCEMENT

Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete reinforcing shall be as specified in Section 03200 CONCRETE REINFORCEMENT.

2.14 PADLOCKS

Padlocks shall comply with Section 08700 'Builders' Hardware

2.15 CABLE FIREPROOFING SYSTEMS

Cable fireproofing systems shall be listed in FM P7825a as a fire-protective coating or tape approved for grouped electrical conductors and shall be suitable for application on the type of medium-voltage cables provided. After being fully cured, materials shall be suitable for use where exposed to oil, water, gases, salt water, sewage, and fungus and shall not damage cable jackets or insulation. Asbestos materials are not acceptable.

2.15.1   Fireproof Coating

Cable fireproofing coatings shall be compounded of water-based thermoplastic resins, flame-retardant chemicals, and inorganic noncombustible fibers and shall be suitable for the application methods used. Coatings applied on bundled cables shall have a derating factor of less than 5 percent, and a dielectric strength of 95 volts per mil minimum after curing.

2.15.2   Fireproofing Tape

Fireproofing tape shall be at least 2 inches wide and shall be a flexible, conformable, polymeric, elastomer tape designed specifically for fireproofing cables.

2.15.3   Plastic Tape

Preapplication plastic tape shall be pressure sensitive, 10 mil thick, conforming to UL 510.

2.16   LIQUID DIELECTRICS

****

NOTE: Select 2 ppm for Air Force projects.

****

Liquid dielectrics for transformers, capacitors, reclosers, and other liquid-filled electrical equipment shall be non-polychlorinated biphenyl (PCB) mineral-oil or less-flammable liquid as specified. Nonflammable fluids shall not be used. Tetrachloroethylene (perchloroethylene) and 1, 2, 4 trichlorobenzene fluids shall not be used. Liquid dielectrics in retrofitted equipment shall be certified by the manufacturer as having less than [50] [2] parts per million (ppm) PCB content. In lieu of the manufacturer's certification, the Contractor may submit a test sample of the dielectric in accordance with ASTM D 923 and have tests performed per ASTM D 4059 at a testing facility approved by the Contracting Officer. Equipment with test results indicating PCB level exceeding [50] [2] ppm shall be replaced.

2.17   FACTORY TESTS

****

NOTE: Delete tests that are not applicable to the project. Refer to TM 5-811-1/AF AFJMAN 32-1080. Tests must be justified.

****

Factory tests shall be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified at least [10]

[_____] days before the equipment is ready for testing. The Contracting Officer reserves the right to witness the tests.

a. Transformers: Manufacturer's standard [routine] [design] [and] [other] tests in accordance with IEEE ANSI/IEEE C57.12.00.

b. Transformers rated 200 kVA and above: Reduced full-wave, chopped-wave, and full-wave impulse test on each line and neutral terminal, in accordance with IEEE ANSI/IEEE C57.98.

c. High-Voltage Air Switches: Manufacturer's standard tests in accordance with IEEE ANSI/IEEE C37.34 and IEEE ANSI/IEEE C37.41.

d. Protective Relays: Seismic tests in accordance with IEEE ANSI/IEEE C37.98. Surge withstand tests in accordance with IEEE ANSI/IEEE C37.90.1.

e. Relaying Current Transformers: Manufacturer's standard tests in accordance with IEEE ANSI/IEEE C57.13.

f. Instrument Current Transformers: Manufacturer's standard tests in accordance with IEEE ANSI/IEEE C57.13.

g. Factory Preformed Terminations: Wet withstand voltage tests in accordance with IEEE Std 48 for the next higher BIL level.

h. Outdoor Switchgear: Manufacturer's standard tests in accordance with IEEE ANSI/IEEE C37.20.1, IEEE ANSI/IEEE C37.20.2, and IEEE ANSI/IEEE C37.20.3.

i. Electrical Power Insulators: Manufacturer's standard tests in accordance with ANSI C29.1.

j. [_____].

2.18 FENCING

Fencing shall conform to the requirements of Section 02821 CHAIN LINK FENCE.

2.19 COORDINATED POWER SYSTEM PROTECTION

****

NOTE: The requirement for the studies in this section depends on the complexity and extent of the power system. Delete this requirement for: project of limited scope; projects having protective devices which are not adjustable or for which coordination is not possible (standard molded case circuit breakers); projects involving simple extension of 600 volt level service to a building or facility from an existing transformer (750 kVA or less); or projects involving simple extension of 600 volt level service to a building or facility from a new transformer (750 kVA or less).

The designer will be responsible for specifying the requirement for fuses, circuit breakers, protective relays, or other protective devices associated with

the project and depecting them on the drawings. The protective devices should be selected and specified to protect electrical power system conductors or equipment against sustained overloads, in-rush conditions, electrical faults, or other abnormal power system or equipment operating conditions, in accordance with TM 5-811-14, COORDINATED POWER SYSTEMS PROTECTION and IEEE Std 242, and IEEE Std 141.

The complexity and extent of coordinated power system protection depends on the type of buildings or facilities or utilities required, on the load demand of facilities, and on the quantity and types of facilities to be constructed. Facilities having a relatively-low power demand (e.g., 2500 kVA or less) generally require protection of an incoming aerial distribution line or underground, medium-voltage feeder, low-voltage feeders to individual items of equipment, or to power distribution equipment, and branch circuits. More complex projects such as facilities with generating capacity, large motors, or larger load demands, will require more detailed and extensive coordinated power system protection.

Independent of the type or types of facilities or load demands, the coordinated power system protection will be based on: economics, simplicity, and the electrical power availability dictated by the Using Agency or Service, or by the functional use of the facilities or utilities; required to provide maximum power service with a minimum of power interruptions; and the operating speed of protective devices required to minimize damage to electrical components or items of equipment and to prevent injury to personnel and nuisance tripping.

Unless otherwise approved, a dc power source will be shown and specified to ensure proper closing and tripping of protective devices which require a reliable power source during outage of the normal alternating-current power source.
****

Analyses shall be prepared to demonstrate that the equipment selected and system constructed meet the contract requirements for equipment ratings, coordination, and protection. They shall include a load flow analysis, a fault current analysis, and a protective device coordination study. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last three years. The Contractor shall provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

2.19.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: [the source bus and extend down to system bused where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses.] [the source bus and extended through the secondary side of transformers for medium voltage distribution feeders.] [the source bus and extend through [outgoing breakers] [outgoing medium voltage feeders, down to the individual protective devices for medium voltage radial taps] [outgoing medium voltage feeders, through the secondary side of transformers] [as indicated] for main electric supply substations.] [the nearest upstream device in the existing source system and extend through the downstream devices at the load end.]

2.19.2 Determination of Facts

****

NOTE: Require the Contractor to obtain an available fault capacity at the power source or provide a fault capacity on which he is to base his analysis. Delete the unused option.

****

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. [The Contractor shall coordinate with the [commercial power company] [_____] for fault current availability at the site.] [The Contractor shall utilize the fault current availability indicated as a basis for fault current studies.]

2.19.3 Single Line Diagram

A single line diagram shall be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformation point shall have a unique identifier. If a fault-impedance diagram is provided, impedance data shall be shown. Locations of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

2.19.4 Fault Current Analysis

2.19.4.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE Std 242, and IEEE Std 399.

2.19.4.2 Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedances shall be those proposed. Data shall be documented in the report.

2.19.5 Coordination Study

The study shall demonstrate that the maximum possible degree of selectively has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study shall include a description of the coordination of the protective devices in this project. Provide a written narrative that describes: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap); coordination between upstream and downstream devices; and any relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost changes (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

2.19.6 Study Report

a. The report shall include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.

b. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.

c. The report shall document [utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristics curves, current transformer ratios, and relay device numbers and settings;] [and] [existing power system data including time-current characteristic curves and protective device ratings and settings.]

d. The report shall contain fully coordinated composite time-current characteristic curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.

e. The report shall provide the calculation performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Circuits installed aerially shall conform to the requirements of Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL. Steel conduits installed underground shall be installed and protected from corrosion in conformance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of

NFPA 70 and IEEE C2 as applicable.

3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

3.1.3 Disposal of Liquid Dielectrics

PCB-contaminated dielectrics must be marked as PCB and transported to and incinerated by an approved EPA waste disposal facility. The Contractor shall furnish certification of proper disposal. Contaminated dielectrics shall not be diluted to lower the contamination level.

3.2 CABLE AND BUSWAY INSTALLATION

The Contractor shall obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, etc. The Contractor shall then [prepare a checklist of significant requirements] [perform pulling calculations and prepare a pulling plan] which shall be submitted along with the manufacturers instructions in accordance with SUBMITTALS.

3.2.1 Cable Installation Plan and Procedure

Cable shall be installed strictly in accordance with the cable manufacturer's recommendations. Each circuit shall be identified by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, handhole, junction box, and each terminal. Each tag shall contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

3.2.1.1 Cable Inspection

The cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable in accordance with the cable manufacturer's recommendations.

3.2.1.2 Duct Cleaning

Duct shall be cleaned with an assembly that consists of a flexible mandrel (manufacturers standard product in lengths recommended for the specific size and type of duct) that is 1/4 inch less than inside diameter of duct, 2 wire brushes, and a rag. The cleaning assembly shall be pulled through conduit a minimum of 2 times or until less than a volume of 8 cubic inches of debris is expelled from the duct.

3.2.1.3 Duct Lubrication

The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacturer's recommendations.

3.2.1.4 Cable Installation

The Contractor shall provide a cable feeding truck and a cable pulling winch as required. The Contractor shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manilla rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall not exceed cable manufacturer's recommendations. The Contractor shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 50 degrees F temperature for at least 24 hours before installation.

3.2.1.5 Cable Installation Plan

The Contractor shall submit a cable installation plan for all cable pulls in accordance with the detail drawings portion of paragraph SUBMITTALS. Cable installation plan shall include:

a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.

b. List of cable installation equipment.

c. Lubricant manufacturer's application instructions.

d. Procedure for resealing cable ends to prevent moisture from entering cable.

e. Cable pulling tension calculations of all cable pulls.

f. Cable percentage conduit fill.

g. Cable sidewall thrust pressure.

h. Cable minimum bend radius and minimum diameter of pulling wheels used.

i. Cable jam ratio.

j. Maximum allowable pulling tension on each different type and size of conductor.

k. Maximum allowable pulling tension on pulling device.

3.2.2 Duct Line

[Medium-voltage cables] [Low-voltage cables] [Cables] shall be installed in duct lines where indicated. [Cable splices in low-voltage cables shall be made in manholes and handholes only, except as otherwise noted.] [Cable joints in medium-voltage cables shall be made in manholes or approved pullboxes only.] Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

3.2.3 Direct-Burial

****

NOTE: Specify cover requirements in accordance with NFPA 70 and IEEE C2. Specify depth of frost line. Coordinate with CEGS-02316 for trenching and backfilling requirements.

****

[Medium-voltage cables] [Low-voltage cables] [Cables] shall be buried directly in the earth as indicated. Minimum cover from the top of a cable to finished grade shall be [_____] inches, but not less than the depth of the frost line, [_____].

3.2.3.1 Trenching

Trenches for direct-burial cables shall be excavated to depths required to provide the minimum necessary cable cover. Bottoms of trenches shall be smooth and free of stones and sharp objects. Where bottoms of trenches comprise materials other than sand, a 3 inch layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil.

3.2.3.2 Cable Burial

****

NOTE: Where soil is known to be rocky, provide selected backfill for cable protection. Specify bend radius in accordance with NFPA 70.

****

Cables shall be unreeled along the sides of or in trenches and carefully placed on sand or earth bottoms. Pulling cables into direct-burial trenches from a fixed reel position will not be permitted, except as required to pull cables through conduits under paving or railroad tracks. Where cables cross, a separation of at least 3 inches shall be provided, unless each cable circuit is protected by a nonmetallic conduit sleeve at the crossing. Where single-conductor cable is installed, all 3 phases and the neutral shall be installed in the same sleeve. Bend radius of any cable shall be not less than [8] [12] [_____] times the diameter of the cable. In no case shall cables be left under longitudinal tension. The first 6 inch layer of backfill shall be of sand. Machine compaction shall not be used within 6 inches of the cable.

3.2.3.3 Other Requirements

Where direct-burial cables cross under roads or other paving exceeding5 feet in width, such cables shall be installed in concrete-encased ducts. Where direct-burial cables cross under railroad tracks, such cables shall be installed in reinforced concrete-encased ducts. Ducts shall extend at least 1 foot beyond each edge of any paving and at least 5 feet beyond each side of any railroad tracks. Cables may be pulled into duct from a fixed reel where suitable rollers are provided in the trench. Where direct burial cable transitions to duct-enclosed cable, direct-burial cables shall be centered in duct entrances, and a waterproof nonhardening mastic compound shall be used to facilitate such centering. If paving or railroad tracks are in place where cables are to be installed, coated rigid steel conduits driven under the paving or railroad tracks may be used in lieu of concrete-encased ducts. Damage to conduit coatings shall be prevented by providing ferrous pipe jackets or by predrilling. Where cuts are made in any paving, the paving and subbase shall be restored to their original condition.

3.2.3.4 Medium-Voltage Cable Joints or Low-Voltage Cable Splices

Cable joints or splices in direct-burial cables are not permitted in runs of 1000 feet or less, nor at intervals of less than 1000 feet in longer runs, except as required for taps. Locations of cable joints or splices in shorter intervals, where required to avoid obstructions or damage to cables, shall be approved. Cable joints or splices in direct burial installations shall be installed in above-ground junction boxes or in cast metal splice boxes suitable for direct burial use. Cable joints or splices in duct banks shall be made only in manholes, handholes, or pullboxes.

3.2.3.5 Cable Markers

****

NOTE: Coordinate with CEGS-02316 for underground marking requirements.

****

Markers shall be located [as indicated] [near the ends of cable runs, at each cable joint or splice, at approximately every 500 feet along cable runs, and at changes in direction of cable runs]. In addition to markers, a 5 mil, brightly colored plastic tape not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers, or other approved dig-in warning indication, shall be placed approximately 12 inches below finished grade levels of trenches.

3.2.4 Insect and Rodent Damage

****

NOTE: In areas where insect and rodent damage to buried cable is a problem, the following steps should be considered:

a. Specify armored cable.

b. Specify next higher cable voltage rating. Utility company research indicates that the greater dielectric strength is effective.

c. Specify full concentric neutral.

d. Specify animal guards around existing concrete pads. Animal guards include fences, and also guards to close holes in concrete pads.

e. On new installations, specify buried fiberglass pads that animals cannot get under.

f. Avoid toxic chemicals.

g. Specify fenced enclosure where required.

****

[Animal guards shall be installed as shown.] [Buried fiberglass pads shall be installed as shown.]

3.2.5 Electric Manholes

Cables shall be routed around the interior walls and securely supported from walls on cables racks. Cable routing shall minimize cable crossover, provide access space for maintenance and installation of additional cables, and maintain cable separation in accordance with IEEE C2.

3.2.6 Busway Installation

Busways penetrating walls shall have wall flanges installed on both surfaces of walls. Wall openings shall be approximately 1/4 inch larger than the busway on each of the 4 busway sides, and openings shall be sealed with a suitable compound. Fire barriers shall be provided when penetrating fire rated walls. Fire barriers shall have a rating equal to the fire wall rating. A weather barrier shall be used when a busway penetrates an exterior wall. Busways shall be supported at intervals not exceeding 10 feet and shall be braced to prevent lateral movement.

3.3 CABLE JOINTS

Medium-voltage cable joints shall be made by qualified cable splicers only. Qualifications of cable splicers shall be submitted in accordance with paragraph SUBMITTALS. Shields shall be applied as required to continue the shielding system through each entire cable joint. Shields may be integrally molded parts of preformed joints. Shields shall be grounded at each joint or in accordance with manufacturer's recommended practice. Cable joints shall provide insulation and jacket equivalent to that of the associated cable. Armored cable joints shall be enclosed in compound-filled, cast-iron or alloy, splice boxes equipped with stuffing boxes and armor clamps of a suitable type and size for the cable being installed.

3.4 FIREPROOFING

****

NOTE: Refer to TM 5-811-1/AF AFJMAN 32-1080 for guidance regarding flameproofing of cables in manholes.

****

[Each medium-voltage cable and conductor in manholes shall be fire-proofed for their entire length within the manhole. Where cables and conductors have been lubricated to enhance pulling into ducts, the lubricant shall be removed from cables and conductors exposed in the manhole before fireproofing.] [Fire-stops shall be installed in each conduit entering or leaving a manhole.]

3.4.1 Tape Method

Before application of fireproofing tape, plastic tape wrapping shall be applied over exposed metallic items such as the cable ground wire, metallic outer covering, or armor to minimize the possibility of corrosion from the fireproofing materials and moisture. Before applying fireproofing tape, irregularities of cables, such as at cable joints, shall be evened out with insulation putty. A flexible conformable polymeric elastomer fireproof tape shall be wrapped tightly around each cable spirally in 1/2 lapped wrapping or in 2 butt-jointed wrappings with the second wrapping covering the joints of the first.

3.4.2 Sprayable Method

Manholes shall be power ventilated until coatings are dry and dewatered and the coatings are cured. Ventilation requirements shall be in accordance with the manufacturer's instruction, but not less than 10 air changes per hour shall be provided. Cable coatings shall be applied by spray, brush, or glove to a wet film thickness that reduces to the dry film thickness approved for fireproofing by FM P7825a. Application methods and necessary safety precautions shall be in accordance with the manufacturers instructions. After application, cable coatings shall be dry to the touch in 1 to 2 hours and fully cured in 48 hours, except where the manufacturer has stated that because of unusual humidity or temperature, longer periods may be necessary.

3.5 DUCT LINES

3.5.1 Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes.

3.5.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

3.5.3 Concrete Encasement

****

NOTE: For crossings of existing railroads and airfield pavements greater than 15.2 m (50 feet) in length, the pre-drilling method or the jack-and-sleeve method will be used.

****

Ducts requiring concrete encasements shall comply with NFPA 70, except that electrical duct bank configurations for ducts 6 inches in diameter shall be determined by calculation and as shown on the drawings. The separation between adjacent electric power and communication ducts shall conform to IEEE C2. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. The Contractor shall submit proposed bonding method for approval in accordance with the detail drawing portion of paragraph SUBMITTALS. At any point, except railroad and airfield crossings, tops of concrete encasements shall be not less than the cover requirements listed in NFPA 70. At railroad and airfield crossings, duct lines shall be encased with concrete and reinforced as indicated to withstand specified surface loadings. Tops of concrete encasements shall be not less than 5 feet below tops of rails or airfield paving unless otherwise indicated. Where ducts are jacked under existing pavement, rigid steel conduit will be installed because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 50 feet in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 4 feet on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 6 inches vertically.

3.5.4 Nonencased Direct-Burial

****
NOTE: Specify cover requirements in accordance with NFPA 70 and IEEE C2. Specify frost line depth.
****

Top of duct lines shall be below the frost line depth of [_____] inches, but not less than [_____] inches below finished grade and shall be installed with a minimum of 3 inches of earth around each duct, except that between adjacent electric power and communication ducts, 12 inches of earth is required. Bottoms of trenches shall be graded toward manholes or handholes and shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand, a 3 inch layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least 6 inches. The first 6 inch layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in3 to 6 inch layers. Duct banks may be held in alignment with earth. However, high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.

3.5.5 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

3.5.5.1 Bituminized-Fiber Ducts

****
NOTE: Bituminized fiber duct should be specified only for connection to existing bituminized fiber duct systems. Delete the paragraph if not required. Specify thin-wall or schedule 40 plastic duct for concrete encasement and thick-wall or schedule 40 or schedule 80 plastic duct for direct-burial and riser applications (riser bends should be metallic conduit where cables are to be pulled into ductline).
****

Bituminized-fiber ducts shall be used to interface with existing bituminized-fiber duct as shown. To ensure a watertight joint, tapered ends or joints of the same material as the ducts shall be swabbed with bituminous or joint-sealing compound before couplings are applied. Plastic or nonmetallic couplings shall be tightly driven onto unswabbed ducts. Due to the brittleness of plastic couplings at low temperatures, such couplings shall not be installed when temperatures are below 0 degrees F. Couplings shall be warmed in hot water or by another approved method when installed at temperatures below 32 degrees F.

3.5.5.2 Plastic Duct

Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.

3.5.6 Duct Line Markers

****

NOTE: Coordinate with CEGS-02316 for underground marking requirements.

****

Duct line markers shall be provided [as indicated] [at the ends of long duct line stubouts or for other ducts whose locations are indeterminate because of duct curvature or terminations at completely below-grade structures]. In addition to markers, a 5 mil brightly colored plastic tape, not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of such lines.

3.6 MANHOLES, HANDHOLES, AND PULLBOXES

3.6.1 General

Manholes shall be constructed approximately where shown. The exact location of each manhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving. The location of each manhole shall be approved by the Contracting Officer before construction of the manhole is started. Manholes shall be the type noted on the drawings and shall be constructed in accordance with the applicable details as indicated. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. The Contractor may at his option utilize monolithically constructed precast-concrete manholes having the required strength and inside dimensions as required by the drawings or specifications. In paved areas, frames and covers for manhole and handhole entrances in vehicular traffic areas shall be flush with the finished surface of the paving. In unpaved areas, the top of manhole covers shall be approximately 1/2 inch above the finished grade. Where existing grades that are higher than finished grades are encountered, concrete assemblies designed for the purpose shall be installed to elevate temporarily the manhole cover to existing grade level. All duct lines entering manholes must be installed on compact soil or otherwise supported when entering a manhole to prevent shear stress on the duct at the point of entrance to the manhole. Duct lines entering cast-in-place concrete manholes shall be cast in-place with the manhole. Duct lines entering precast concrete manholes through a precast knockout penetration shall be grouted tight with a portland cement mortar. PVC duct lines entering precast manholes through a PVC endbell shall be solvent welded to the endbell. A cast metal grille-type sump frame and cover shall be installed over the manhole sump. A cable-pulling iron shall be installed in the wall opposite each duct line entrance.

3.6.2 Electric Manholes

****

NOTE: Provide the plastic coating or supports where corrosive conditions in manholes are anticipated. Determine from the Using Agency what types of communication cables the Contractor should provide.

****

Cables shall be securely supported from walls by hot-dip galvanized cable racks with a plastic coating over the galvanizing and equipped with adjustable hooks and insulators. The number of cable racks indicated shall be installed in each manhole and not less than 2 spare hooks shall be installed on each cable rack. Insulators shall be made of high-glazed porcelain. Insulators will not be required on spare hooks.

3.6.3 Communications Manholes

The number of hot-dip galvanized cable racks with a plastic coating over the galvanizing indicated shall be installed in each telephone manhole. Each cable rack shall be provided with 2 cable hooks. Cables for the telephone and communication systems will be installed by others.

3.6.4 Handholes

Handholes shall be located approximately as shown. Handholes shall be of the type noted on the drawings and shall be constructed in accordance with the details shown.

3.6.5 Pullboxes

Pullbox tops shall be flush with sidewalks or curbs or placed 1/2 inchabove surrounding grades when remote from curbed roadways or sidewalks. Covers shall be marked "Low-Voltage" and provided with 2 lifting eyes and 2 hold-down bolts. Each box shall have a suitable opening for a ground rod. Conduit, cable, ground rod entrances, and unused openings shall be sealed with mortar.

3.6.6 Ground Rods

A ground rod shall be installed at the manholes, handholes and pullboxes. Ground rods shall be driven into the earth before the manhole floor is poured so that approximately 4 inches of the ground rod will extend above the manhole floor. When precast concrete manholes are used, the top of the ground rod may be below the manhole floor and a No. 1/0 AWG ground conductor brought into the manhole through a watertight sleeve in the manhole wall.

3.7 PAD-MOUNTED EQUIPMENT INSTALLATION

****

NOTE: Provide a typical concrete pad detail for

each different piece of equipment by size range (typical dimensions and weight). The pad detail should depict welded wire fabric or steel reinforcing bars, sized and spaced as required to support the equipment. Exact pad dimensions are equipment specific and are the responsibility of the Contractor. Require grouting of rectangular holes (windows) in the concrete pad if rodent intrusion is a problem.

****

Pad-mounted equipment, shall be installed on concrete pads in accordance with the manufacturer's published, standard installation drawings and procedures, except that they shall be modified to meet the requirements of this document. Units shall be installed so that they do not damage equipment or scratch painted or coated surfaces. After installation, surfaces shall be inspected and scratches touched up with a paint or coating provided by the manufacturer especially for this purpose. Three-phase transformers shall be installed with [_____] phase sequence. Primary taps shall be set at [_____].

3.7.1 Concrete Pads

3.7.1.1 Construction

Concrete pads for pad-mounted electrical equipment [may be either pre-fabricated or] [shall be] poured-in-place. Pads shall be constructed as indicated, except that exact pad dimensions and mounting details are equipment specific and are the responsibility of the Contractor. Tops of concrete pads shall be level and shall project 4 inches above finished [floor] [paving or grade] and sloped to drain. Edges of concrete pads shall have 3/4 inch chamfer. Conduits for primary, secondary, and grounding conductors shall be set in place prior to placement of concrete pads. Where grounding electrode conductors are installed through concrete pads, PVC conduit sleeves shall be installed through the concrete to provide physical protection. To facilitate cable installation and termination, the concrete pad shall be provided with a rectangular hole below the primary and secondary compartments, sized in accordance with the manufacturer's recommended dimensions. Upon completion of equipment installation the rectangular hole shall be filled with masonry grout.

3.7.1.2 Concrete and Reinforcement

Concrete work shall have minimum 3000 psi compressive strength and comform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete pad reinforcement shall be in accordance with Section 03200 CONCRETE REINFORCEMENT.

3.7.1.3 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.7.2 Padlocks

Padlocks shall be provided for pad-mounted equipment and for each fence gate. Padlocks shall be keyed [alike] [as directed by the Contracting Officer].

3.7.3   Fencing

****
NOTE: Delete this paragraph when fencing is not required. Ensure adequate space between the transformer and the fence for equipment operation in accordance with IEEE C2.
****

Fencing shall conform to the requirement of and be installed in accordance with Section 02821 CHAIN LINK FENCE. Fences shall provide working clearances for operation and maintenance in accordance with IEEE C2. The entire space between fences and concrete pads shall be excavated to a minimum depth of 4 inches below finished gradelines, shall be graded to reasonably level surfaces, and filled with well-compacted clean coarse gravel or crushed stone of 1/2 to 1-1/2 inches graded size up to finished gradelines. Space between fences and concrete pads shall be excavated to a minimum depth of 4 inches below finished gradelines, shall be graded to reasonably level surfaces, and filled with well-compacted clean coarse gravel or crushed stone of 1/2 to 1-1/2 inches graded size up to finished gradelines.

3.8   CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

Connections between aerial and underground systems shall be made as shown. Underground cables shall be extended up poles in [guards] [conduit] to cable terminations. Conduits shall be secured to the poles by 2-hole galvanized steel pipe straps spaced not more than 10 feet apart and with 1 strap not more than 12 inches from any bend or termination. Cable guards shall be secured to poles in accordance with the manufacturer's published procedures. Conduits shall be equipped with bushings to protect cables and minimize water entry. Capnut potheads shall be used to terminate medium-voltage multiple-conductor cable. Cables shall be supported by devices separate from the conduit or guard, near their point of exit from the conduit or guard.

3.8.1   Pole Installation

Pole installation shall be in accordance with Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

3.9   CONNECTIONS TO BUILDINGS

****
NOTE: Specify a depth below the frost line and coordinate with CEGS-16415 ELECTRICAL WORK, INTERIOR. Specify or depict conduit sealing method.
****

Cables shall be extended into the various buildings as indicated, and shall be connected to the first applicable termination point in each building. Interfacing with building interior conduit systems shall be at conduit stubouts terminating 5 feet outside of a building and [2] [_____] feet below finished grade as specified and provided under Section 16415

ELECTRICAL WORK, INTERIOR. After installation of cables, conduits shall be sealed [with caulking compound] [_____] to prevent entrance of moisture or gases into buildings.

3.10 GROUNDING

****

NOTE: The designer will specify the grounding configuration and the number and type of electrodes required. See TM 5-811-1/AF AFJMAN 32-1080 for guidance. Coordinate with NFPA 70 and IEEE C2.

****

A ground [mat] [ring] consisting of the indicated configuration of bare copper conductors and driven ground rods shall be installed [under] [around] pad-mounted equipment as shown. Equipment frames of metal-enclosed equipment, and other noncurrent-carrying metal parts, such as cable shields, cable sheaths and armor, and metallic conduit shall be grounded. At least 2 connections shall be provided from [a transformer,] [a switchgear ground bus,] [and] [a unit substation] to the ground mat. Metallic frames and covers of handholes and pull boxes shall be grounded by use of a braided, copper ground strap with equivalent ampacity of No. 6 AWG.

3.10.1 Grounding Electrodes

****

NOTE: Modify and/or delete in accordance with project requirements.

The designer should investigate the soil resistivity during the preliminary design phase to determine the design required to ensure that the grounding values are obtained. For areas where the water table is low and/or the soil resistivity is high (such as volcanic soils, sand, or rock), delete the additional electrode provisions and provide a design to meet the site requirements.

****

Grounding electrodes shall be installed as shown on the drawings and as follows:

a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade.

b. Ground mat - A ground mat shall be installed as shown consisting of bare copper conductors installed [12] [18] [24] inches, plus or minus 3 inches, below the finished top of soil grade. Mat conductors shall be bonded to all rod electrodes, electrolytic electrodes, and to all other intersecting mat conductors. Mat conductors shall be sized as shown on the drawings.

c. Ground ring - A ground ring shall be installed as shown consisting of bare copper conductors installed [12] [18] [24] inches, plus or minus 3 inches, below finished top of soil grade. Ground ring conductors shall be [sized as shown] [No. 2 AWG, minimum].

d. Additional electrodes - When the required ground resistance is not met, additional electrodes shall be provided [interconnected with grounding conductors] [as indicated] to achieve the specified ground resistance. The additional electrodes will be [up to three, [8] [10] feet rods spaced a minimum of [10] [12] feet apart] [a single extension-type rod, [5/8] [3/4] inch diameter, up to 30 feet long, [driven perpendicular to grade] [coupled and driven with the first rod]]. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

3.10.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors, in compliance with UL 467, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

3.10.3 Grounding and Bonding Conductors

Grounding and bonding conductors include conductors used to bond transformer enclosures and equipment frames to the grounding electrode system. Grounding and bonding conductors shall be sized as shown, and located to provide maximum physical protection. Bends greater than 45 degrees in ground conductors are not permitted. Routing of ground conductors through concrete shall be avoided. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground conductor, and the opening shall be sealed with a suitable compound after installation.

3.10.4 Surge Arrester Grounding

****

NOTE: Provide a "detail" for surge arrester grounding. See TM 5-811-1/AF AFJMAN 32-1080 for guidance. For ungrounded and single-grounded systems, modify paragraph in accordance with IEEE C2 and TM 5-811-1/AF AFJMAN 32-1080.

****

Surge arresters and neutrals shall be bonded directly to the transformer enclosure and then to the grounding electrode system with a bare copper conductor, sized as shown. Lead lengths shall be kept as short as practicable with no kinks or sharp bends.

3.10.5 Manhole, Handhole, or Concrete Pullbox Grounding

Ground rods installed in manholes, handholes, or concrete pullboxes shall be connected to cable racks, cable-pulling irons, the cable shielding, metallic sheath, and armor at each cable joint or splice by means of a No. 4 AWG braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. Grounding electrode conductors shall be neatly and firmly attached to manhole or handhole walls and the amount of exposed bare wire shall be held to a minimum.

3.10.6 Metal Splice Case Grounding

Metal splice cases for medium-voltage direct-burial cable shall be grounded by connection to a driven ground rod located within 2 feet of each splice box using a grounding electrode conductor having a current-carrying capacity of at least 20 percent of the individual phase conductors in the associated splice box, but not less than No. 6 AWG.

3.10.7 Riser Pole Grounding

A single continuous vertical grounding electrode conductor shall be installed on each riser pole and connected directly to the grounding electrodes indicated on the drawings or required by these specifications. All equipment, neutrals, surge arresters, and items required to be grounded shall be connected directly to this vertical conductor. The grounding electrode conductor shall be sized as shown. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding2 feet.

3.11 FIELD TESTING

****

NOTE: Select types to suit project conditions and delete all others. Delete all paragraphs not applicable. Tests must be justified.

****

3.11.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer [_____] days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field test reports shall be signed and dated by the Contractor.

3.11.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.11.3 Ground-Resistance Tests

The resistance of [each grounding electrode] [each grounding electrode system] [the ground mat] [the ground ring] shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

a. Single rod electrode - [25] [_____] ohms.

b. Multiple rod electrodes - [_____] ohms.

c. Ground mat - [_____] ohms.

d. Ground ring - [_____] ohms.

3.11.4 Ground-Mat Connection Inspection

All below-grade ground-mat connections will be visually inspected by the Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer [_____] hours before the site is ready for inspection.

3.11.5 Medium-Voltage Cable Test

****

NOTE: If the installation is tapping a new feeder to an existing feeder using a "T" splice, modify the paragraph to indicate that when existing cable cannot be readily disconnected, the system should only be tested to the lower (after installation) voltage.

****

After installation and before the operating test or connection to an existing system, the medium-voltage cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal and connecting grounds or metallic shieldings or sheaths of the cable as the other terminal for each test. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The test shall be conducted with all splices, connectors, and terminations in place. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with NEMA WC 7 or NEMA WC 8 for the particular type of cable installed, except that 28 kV and 35 kV insulation test voltages shall be in accordance with either AEIC CS5 or AEIC CS6 as applicable, and shall not exceed the recommendations of IEEE Std 404 for cable joints and IEEE Std 48 for cable terminations unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

3.11.6 Low-Voltage Cable Test

****

NOTE: The insulation resistance test (dielectric test) value is based on the recommendation contained in IEEE Std 525, IEEE Guide for the Design and

Installation of Cable Systems in Substations.
****

Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

3.11.7 Liquid-Filled Transformer Tests

The following field tests shall be performed on [all liquid-filled transformers] [liquid-filled transformers [_____] kVA and above]. Pass-fail criteria shall be in accordance with transformer manufacturer's specifications.

a. Insulation resistance test phase-to-ground.

b. Turns ratio test.

c. Correct phase sequence.

d. Correct operation of tap changer.

e. [_____]

3.11.8 Dry-Type Transformer Tests

The following field tests shall be performed on [all dry-type transformers] [dry-type transformer [_____] kVA and above]. Pass-fail criteria shall be in accordance with the transformer manufacturer's specifications.

a. Insulation resistance test phase-to-ground.

b. Turns ratio test.

c. [_____]

3.11.9 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers. Pass-fail criteria shall be in accordance with the circuit breaker manufacturer's specifications.

a. Insulation resistance test phase-to-phase.

b. Insulation resistance test phase-to-ground.

c. Closed breaker contact resistance test.

d. Power factor test.

e. High-potential test.

f. [Manual] [and] [electrical] operation of the breaker.

3.11.10 Power Circuit Breaker Tests

****

NOTE: List specific breakers to be tested. Delete entirely if test not required.

****

The following power circuit breakers shall be tested in accordance with ANSI C37.50.

a. [_____].

b. [_____].

c. [_____].

3.11.11 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings shall be implemented in accordance with the coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE ANSI/IEEE C57.13.

3.11.12 Pre-Energization Services

Calibration, testing, adjustment, and placing into service of the installation shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of 2 years of current product experience. The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to ensure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment to ensure packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services shall be provided, but are not limited to, are the following:

a. Secondary unit substation

b. Pad-mounted transformers

c. Panelboards

d. Switchboards

e. Metal-enclosed switchgear

f. Busways

g. Switches

3.11.13 Operating Tests

After the installation is completed, and at such times as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the requirements herein. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

3.12 MANUFACTURER'S FIELD SERVICE

****
NOTE: Delete if not required.
****

3.12.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of [_____] hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, and servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A [_____] [VHS] format video tape of the entire training session shall be submitted.

3.12.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

3.13 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-16415 (August 1996)**
U.S. ARMY CORPS OF ENGINEERS **--------------------------**
Superseding
CEGS-16415 (December 1991)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 3 (May 1998)
Includes Text Adjustment change (Section 01300 Reference)(June 1997)

Latest Notice change indicated by CHG tags

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DIVISION 16 - ELECTRICAL

SECTION 16415

ELECTRICAL WORK, INTERIOR

08/96

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DEPARTMENT OF THE ARMY | **CEGS-16415 (August 1996)**
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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 16415

ELECTRICAL WORK, INTERIOR
08/96

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NOTE: This guide specification covers the requirements for interior electrical work. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(1995) Code for Electricity Metering
ANSI C12.4	(1984; R 1996) Mechanical Demand Registers
ANSI C12.10	(1987) Electromechanical Watthour Meters
ANSI C12.11	(1987; R 1993) Instrument Transformers for Revenue Metering, 10 kV BIL Through 350 kV BIL (0.6 kV NSV Through 69 kV NSV)
ANSI C37.16	(1988; C37.16a; R 1995) Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations
ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments
ANSI C57.12.10	(1987) Safety Requirements for Transformers 230 kV and Below 833/958 Through 8333/10417 kVA, Single-Phase, and 750/862 Through 60 000/80 000/100 000 kVA, Three-Phase Without Load Tap Charging; and 3750/4687 Through 60 000/80 000/100 000 kVA With Load Tap Charging
ANSI C57.12.13	(1982) Conformance Requirements for Liquid-Filled Transformers Used in Unit Installations, Including Unit Substations
ANSI C57.12.27	(1982) Conformance Requirements for Liquid-Filled Distribution Transformers Used in Pad-Mounted Installations, Including Unit Substations
ANSI C57.12.50	(1981; R 1989) Ventilated Dry-type Distribution Transformers 1 to 500 kVA, Single-Phase; and 15 to 500 kVA, Three-Phase with High-Voltage 601 to 34 500 Volts, Low-Voltage 120 to 600 Volts
ANSI C57.12.51	(1981; R 1989) Ventilated Dry-Type Power Transformers, 501 kVA and Larger, Three-Phase, with High-Voltage 601 to 34 500 Volts, Low-Voltage 208Y/120 to 4160 Volts
ANSI C57.12.52	(1981; R 1989) Sealed Dry-Type Power Transformers, 501 kVA and Larger, Three-Phase with High-Voltage 601 to 34 500 Volts, Low-Voltage 208Y/120 to 4160 Volts
ANSI C57.12.70	(1978; R 1993) Terminal Markings and Connections for Distribution and Power

	Transformers
ANSI C80.5	(1995) Rigid Aluminum Conduit
ANSI C82.1	(1985; C82.1a; C82.1b; C82.1c; C82.1d; C82.1e; R 1992) Specifications for Fluorescent Lamp Ballasts
ANSI C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
ANSI C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 1	(1995) Hard-Drawn Copper Wire
ASTM B 8	(1995) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 709	(1992; R 1997) Laminated Thermosetting Materials
ASTM D 4059	(1996) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 18	Industrial, Scientific, and Medical Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE ANSI/IEEE C37.13	(1990; R 1995) Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE ANSI/IEEE C37.20.1	(1993) Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
IEEE ANSI/IEEE C57.12.00	(1993) IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE ANSI/IEEE C57.12.80	(1978; R 1992) Terminology for Power and Distribution Transformers
IEEE ANSI/IEEE C57.12.90	(1993) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers
IEEE ANSI/IEEE C57.13	(1993) Instrument Transformers

IEEE ANSI/IEEE C57.98	(1993) Guide for Transformer Impulse Tests
IEEE ANSI/IEEE C57.100	(1986; R 1992) Test Procedure for Thermal Evaluation of Oil-Immersed Distribution Transformers
IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
IEEE Std 242	(1986; R 1991) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
IEEE Std 399	(1990) Recommended Practice for Industrial and Commercial Power Systems Analysis

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA BU 1	(1994) Busways
NEMA FU 1	(1986) Low Voltage Cartridge Fuses
NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 3	(1993) Industrial Control and Systems Factory Built Assemblies
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA LE 4	(1987) Recessed Luminaires, Ceiling Compatibility
NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3) Motors and Generators
NEMA MG 10	(1994) Energy Management Guide for Selection and Use of Polyphase Motors
NEMA OS 1	(1989) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA OS 2	(1986; Errata Aug 1986; R 1991)

	Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
NEMA PB 1	(1990) Panelboards
NEMA PB 2	(1995) Deadfront Distribution Switchboards
NEMA PE 5	(1985; R 1991) Utility Type Battery Chargers
NEMA RN 1	(1989) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA SG 3	(1995) Power Switching Equipment
NEMA ST 20	(1992) Dry-Type Transformers for General Applications
NEMA TC 2	(1990) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)
NEMA TC 13	(1993) Electrical Nonmetallic Tubing (ENT)
NEMA VE 1	(1996) Metal Cable Tray Systems
NEMA WD 1	(1983; R 1989) General Requirements for Wiring Devices
NEMA WD 6	(1988) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996; Errata 96-4) National Electrical Code
NFPA 101	(1997; Errata 97-1) Life Safety Code

UNDERWRITERS LABORATORIES (UL)

UL 1	(1993; Rev thru Jan 1995) Flexible Metal Conduit
UL 4	(1996) Armored Cable
UL 5	(1996) Surface Metal Raceways and Fittings
UL 6	(1997) Rigid Metal Conduit
UL 20	(1995; Rev thru Jan 1998) General-Use Snap Switches
UL 44	(1997; Rev Aug 1997) Thermoset-Insulated Wires and Cables
UL 50	(1995; Rev thru Oct 1997) Enclosures for Electrical Equipment

UL 67	(1993; Rev thru Nov 1995) Panelboards
UL 83	(1996; Rev Sep 1997) Thermoplastic-Insulated Wires and Cables
UL 98	(1994; R thru Oct 1995) Enclosed and Dead-Front Switches
UL 198B	(1995) Class H Fuses
UL 198C	(1986; Rev thru Feb 1998) High-Interrupting-Capacity Fuses, Current-Limiting Types
UL 198D	(1995) Class K Fuses
UL 198E	(1988; Rev Jul 1988) Class R Fuses
UL 198G	(1988; Rev May 1988) Fuses for Supplementary Overcurrent Protection
UL 198H	(1988; Rev thru Nov 1993) Class T Fuses
UL 198L	(1995; Rev May 1995) D-C Fuses for Industrial Use
UL 360	(1996; Rev thru Oct 1997) Liquid-Tight Flexible Steel Conduit
UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 486A	(1997) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1997; Rev Jun 1997) Wire Connectors for Use with Aluminum Conductors
UL 486C	(1997) Splicing Wire Connectors
UL 486E	(1994; Rev thru Feb 1997) Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
UL 489	(1996; Rev thru Nov 1997) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 498	(1996; Rev thru Nov 1997) Attachment Plugs and Receptacles
UL 506	(1994; Rev Oct 1997) Specialty Transformers
UL 508	(1993; Rev thru Oct 1997) Industrial Control Equipment
UL 510	(1994; Rev thru Nov 1997) Insulating Tape

UL 512	(1993; R Dec 1995) Fuseholders
UL 514A	(1996) Metallic Outlet Boxes
UL 514B	(1997) Fittings for Conduit and Outlet Boxes
UL 514C	(1996) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 542	(1994; Rev May 1997) Lampholders, Starters, and Starter Holders for Fluorescent Lamps
UL 651	(1995; Rev thru Apr 1997) Schedule 40 and 80 Rigid PVC Conduit
UL 651A	(1995; Rev Sep 1996) Type EB and A Rigid PVC Conduit and HDPE Conduit
UL 674	(1994; Rev thru Feb 1997) Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations
UL 698	(1995; Rev thru Dec 1996) Industrial Control Equipment for Use in Hazardous (Classified) Locations
UL 719	(1996) Nonmetallic-Sheathed Cables
UL 797	(1993; Rev thru Mar 1997) Electrical Metallic Tubing
UL 817	(1994; Rev thru Aug 1997) Cord Sets and Power-Supply Cords
UL 844	(1995; Rev thru Aug 1997) Electric Lighting Fixtures for Use in Hazardous (Classified) Locations
UL 845	(1995; Rev Feb 1996) Motor Control Centers
UL 854	(1996) Service-Entrance Cables
UL 857	(1994; Rev thru Nov 1996) Busways and Associated Fittings
UL 869A	(1993; Rev thru Apr 1996) Reference Standard for Service Equipment
UL 877	(1993; Rev thru May 1997) Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations
UL 886	(1994; Rev thru Jan 1997) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 891	(1994; Rev thru Jan 1995) Dead-Front

	Switchboards
UL 924	(1995; Rev thru Oct 97) Emergency Lighting and Power Equipment
UL 935	(1995; Rev thru Apr 1997)Fluorescent-Lamp Ballasts
UL 943	(1993; Rev thru Mar 1997)Ground-Fault Circuit-Interrupters
UL 1004	(1994; Rev thru Feb 1997) Electric Motors
UL 1010	(1995; Rev thru Dec 1996)Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations
UL 1022	(1994) Line Isolation Monitors
UL 1029	(1994; Rev thru Sep 1995) High-Intensity-Discharge Lamp Ballasts
UL 1047	(1995; Rev May 1996) Isolated Power Systems Equipment
UL 1236	(1994; Rev thru Dec 1997) Battery Chargers for Charging Engine-Starter Batteries
UL 1242	(1996; Rev Apr 1997) Intermediate Metal Conduit
UL 1449	(1985; Errata Apr 1986; Rev May 1995) Transient Voltage Surge Suppressors
UL 1564	(1993; Rev Apr 1994) Industrial Battery Chargers
UL 1569	(1995; Rev thru Oct 1997) Metal-Clad Cables
UL 1570	(1995; Rev thru Jun 1997) Fluorescent Lighting Fixtures
UL 1571	(1995; Rev thru Jun 97) Incandescent Lighting Fixtures
UL 1572	(1995; Rev thru Jun 97) High Intensity Discharge Lighting Fixtures
UL 1660	(1994; Rev Jan 1996) Liquid-Tight Flexible Nonmetallic Conduit
UL Elec Const Dir	(1997) Electrical Construction Equipment Directory

1.2 GENERAL

1.2.1 Rules

The installation shall conform to the requirements of NFPA 70 and NFPA 101, unless more stringent requirements are indicated or shown.

1.2.2 Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible. Lighting fixtures, outlets, and other equipment and materials shall be located to avoid interference with mechanical or structural features; otherwise, lighting fixtures shall be symmetrically located according to the room arrangement when uniform illumination is required, or asymmetrically located to suit conditions fixed by design and shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Contractor shall coordinate electrical work with the HVAC and electrical drawings and specifications and provide power related wiring.

1.2.3 Special Environments

1.2.3.1 Weatherproof Locations

Wiring, Fixtures, and equipment in designated locations shall conform to NFPA 70 requirements for installation in damp or wet locations.

1.2.3.2 Hazardous Locations

[Wiring in locations indicated shall conform to the NFPA 70 for Class [I] [II] [III], Division [1] [2] hazardous locations. Equipment shall be suitable for [Group [_____]] [operating temperature of [_____] degrees F].] [Wiring and equipment in locations indicated shall be of the classes, groups, divisions, and suitable for the operating temperature; as indicated.]

1.2.3.3 Ducts, Plenums and Other Air-Handling Spaces

Wiring and equipment in ducts, plenums and other air-handling spaces shall be installed using materials and methods in conformance with NFPA 70unless more stringent requirements are indicated in this specification or on the contract drawings.

1.2.4 Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.2.5 NAMEPLATES

1.2.5.1 Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel. Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with ASTM D 709 with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The front of each panelboard, motor control center, switchgear, and switchboard shall have a nameplate to indicate the phase letter, corresponding color and arrangement of the phase conductors. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 1/4 inch High Letters	Minimum 1/8 inch High Letters
Panelboards	Control Power Transformers
Starters	Control Devices
Safety Switches	Instrument Transformers
Motor Control Centers	
Transformers	
Equipment Enclosures	
Switchgear	
Switchboards	
Motors	

Each panel, section, or unit in motor control centers, switchgear or similar assemblies shall be provided with a nameplate in addition to nameplates listed above, which shall be provided for individual compartments in the respective assembly, including nameplates which identify "future," "spare," and "dedicated" or "equipped spaces."

1.2.5.2 Liquid-Filled Transformer Nameplates

****

NOTE: Delete the following paragraph as appropriate for the project. Coordinate nameplate C information with the manufacturer. Select 2 ppm PCB content for Air Force projects.

****

Power transformers shall be provided with Nameplate C information in accordance with IEEE ANSI/IEEE C57.12.00. Nameplates shall indicate percent impedance, voltage, kVA, frequency, number of phases, cooling class, insulation class, temperature rise, the number of gallons and composition of liquid-dielectric, and shall be permanently marked with a statement that the transformer dielectric to be supplied is non-polychlorinated biphenyl. The Contractor shall furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than [50] [2] ppm PCB content in accordance with paragraph LIQUID DIELECTRICS. Certifications shall be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the [50] [2] ppm PCB content or transformers without certification will be considered as PCB insulated and will not be accepted.

1.2.6 As-Built Drawings

Following the project completion or turnover, within 30 days the Contractor shall furnish 2 sets of as-built drawings to the Contracting Officer.

1.2.7 Recessed Light Fixtures (RLF) Option

****

Include this paragraph in all metric projects only.

****

The Contractor has the option to substitute inch-pound (I-P) RLF to metric RLF. This option shall be coordinated with Section \=09510=\ ACOUSTICAL CEILINGS.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required. Designer will determine which submittals are necessary for adequate quality control and delete all other submittals. For example, on many small projects the short-circuit and protective device coordination studies should be deleted.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Fault Current and Protective Device Coordination Study; [_____].

The study shall be submitted along with protective device equipment submittals. No time extensions or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed shall be based on recommendations of this study, The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Manufacturer's Catalog; [_____].

Data composed of catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists; [_____].

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

Installation Procedures; [_____].

Installation procedures for rotating equipment, transformers, switchgear, battery systems, voltage regulators, and grounding resistors. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test devices and equipment.

SD-04 Drawings

Interior Electrical Equipment; [_____].

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Detail drawings shall show the rating of items and systems and how the components of an item and system are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall show physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded. Detail drawings shall as a minimum include:

a. Transformers.

b. Switchgear.

c. Battery system including calculations for the battery and charger.

d. Voltage regulators.

e. Grounding resistors.

f. Motors and rotating machinery.

g. Motor control centers.

h. Busway systems.

i. Single line electrical diagrams including primary, metering, sensing and relaying, control wiring, and control logic.

j. Sway bracing for suspended luminaires.

Structural drawings showing the structural or physical features of major equipment items, components, assemblies, and structures, including foundations or other types of supports for equipment and conductors. These drawings shall include accurately scaled or dimensioned outline and arrangement or layout drawings to show the physical size of equipment and components and the relative arrangement and physical connection of related components. Weights of equipment, components and assemblies shall be provided when required to verify the adequacy of design and proposed construction of foundations or other types of supports. Dynamic forces shall be stated for switching devices when such forces must be considered in the design of support structures. The appropriate detail drawings shall show the provisions for leveling, anchoring, and connecting all items during installation, and shall include any recommendations made by the manufacturer.

Electrical drawings including single-line and three-line diagrams, and schematics or elementary diagrams of each electrical system; internal wiring and field connection diagrams of each electrical device when published by the manufacturer; wiring diagrams of cabinets, panels, units, or separate mountings; interconnection diagrams that show the wiring between separate components of assemblies; field connection diagrams that show the termination of wiring routed between separate items of equipment; internal wiring diagrams of equipment showing wiring as actually provided for this project. Field wiring connections shall be clearly identified.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures, including changes in related portions of the project and the reasons why, shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

As-Built Drawings; [_____].

The as-built drawings shall be a record of the construction as installed. The drawings shall include all the information shown on the contract drawings, deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full-sized set of prints marked to reflect all deviations, changes, and modifications. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

SD-08 Statements

Onsite Test; GA.

A detailed description of the Contractor's proposed procedures for on-site tests.

SD-09 Reports

Factory Test Reports; GA.

[Six] [_____] copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The conditions specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

Field Test Plan; GA.

A detailed description of the Contractor's proposed procedures for onsite test submitted [20] [30] [_____] days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Field Test Reports; GA.

[Six] [_____] copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The conditions specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

h. Final position of controls and device settings.

SD-13 Certificates

Materials and Equipment; [_____].

The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer. Items which are required to be listed and labeled in accordance with Underwriters Laboratories must be affixed with a UL label that states that it is UL listed. No exceptions or waivers will be granted to this requirement. Materials and equipment will be approved based on the manufacturer's published data.

For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

1.4 WORKMANSHIP

Materials and equipment shall be installed in accordance with NFPA 70, recommendations of the manufacturer, and as shown.

PART 2 PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.1 BUSWAYS

UL 857. Busses shall be [copper] [or] [aluminum]. Enclosures shall be [steel] [aluminum]. Short-circuit ratings, except as indicated, shall be in accordance with NEMA BU 1.

2.1.1 Feeder Busways

Feeder busways shall be [ventilated, except that vertical busways within 6 feet of floors shall be unventilated] [unventilated] low-impedance busway.

2.1.2 Plug-In Busways

Plug-in busways shall be unventilated. [A hook stick of suitable length shall be provided for operating plug-in units from the floor.] [Plug-in units shall be of the circuit-breaker type.] [Plug-in units shall be of the handle-operated switch type equipped with high-interrupting-capacity current-limiting fuses.]

2.2 CABLES AND WIRES

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. [All conductors shall be copper.] [Conductors indicated to be No. 6 AWG or smaller diameter shall be copper. Conductors indicated to be No. 4 AWG and larger diameter shall be either copper or aluminum, unless otherwise indicated or required by manufacturer.]

2.2.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to meet manufacturer's requirements.

2.2.2 Aluminum Conductors

****

NOTE: Select the first option if aluminum conductors are not to be used. Otherwise, select the second option.

****

[Aluminum conductors shall not be used.] [Aluminum conductors shall be AA-8000 series electrical grade aluminum alloy conductors. Type EC-1350 aluminum is unacceptable.]

2.2.3 Insulation

****

NOTE: Ensure conduit fill calculations are based on largest diameter insulation type allowed. Designer may select other insulation types which are better suited for a particular project. For rewiring projects where existing conduit is to be utilized, specify types THHN and THWN.

****

Unless indicated otherwise, or required by NFPA 70, power and lighting wires shall be 600-volt, [Type THWN, THHN, or THW conforming to UL 83] [or] [RHW conforming to UL 44], except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW, THW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.2.4 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.2.5 Service Entrance Cables

Service entrance (SE) and underground service entrance (USE) cables, UL 854.

2.2.6 Non-metallic Sheathed Cable

UL 719, type NM or NMC.

2.2.7 Metal-Clad Cable

****

NOTE: Type MC cable is UL listed and recognized by NFPA for common building applications. MC cable does not protect conductors as well as rigid conduit but is easier to install and relocate.
****

UL 1569; NFPA 70, Type MC cable.

2.2.8 Armored Cable

UL 4; NFPA 70, Type AC cable.

2.2.9 Mineral-Insulated, Metal-Sheathed Cable

UL listed NFPA 70, type MI cable. Sheathing containing asbestos fibers shall not be used.

2.2.10 Flat Conductor Cable

****
NOTE: Type FCC cable has been listed by UL and NFPA for under carpet tile applications. FCC cable is available for power, telephone, and data transmission applications.
****

UL listed NFPA 70, type FCC.

2.2.11 Tray Cable or Power Limited Tray Cable

UL listed; Type TC or PLTC.

2.2.12 Cord Sets and Power-Supply Cords

UL 817.

2.3 CABLE TRAYS

NEMA VE 1 cable trays shall form a wireway system, and shall be of nominal [3] [4] [6] inch depth. Cable trays shall be constructed of [aluminum] [copper-free aluminum] [zinc-coated steel]. Trays shall include splice and end plates, dropouts, and miscellaneous hardware. Edges, fittings, and hardware shall be finished free from burrs and sharp edges. Fittings shall have not less than the load-carrying ability of straight tray sections and shall have manufacturer's minimum standard radius. [Radius of bends shall be [12] [24] [36] inches.] [Radius of bends shall be as shown.]

2.3.1 Trough

Trough-type cable trays shall be of a nominal [6] [12] [18] [24] inch width.

2.3.2 Ladder

Ladder-type cable trays shall be of nominal [6] [12] [18] [24] inch width. Rung spacing shall be on [6] [9] [12] [18] inch maximum centers.

2.3.3 Channel

Channel-type cable trays shall be [3] [4] inch width. Trays shall be one-piece construction having slots spaced not more than 4-1/2 inches on centers.

2.3.4 Cantilever

Cantilever-type, center-hung cable trays may be provided at the Contractor's option in lieu of other cable tray types specified.

2.4 TRANSIENT VOLTAGE SURGE PROTECTION

****

NOTE: Indicate circuits requiring additional transient voltage surge suppression. Provide requirements on the drawings or in a table. Transient voltage surge suppressors (TVSS) shall be UL 1449 listed and labeled; no exception or waiver will be granted to this requirement.

****

Transient voltage surge suppressors shall be provided as indicated. Surge suppressors shall meet the requirements of IEEE C62.41 and be UL listed and labeled as having been tested in accordance with UL 1449. Surge suppressor ratings shall be [as indicated] [[_____] volts rms, operating voltage; [50] [60] Hz; [1-phase] [3-phase]; [2] [3] [4] wire with ground; transient suppression voltage (peak let-through voltage) of [_____] volts]. Fuses shall not be used as surge suppression.

2.5 CHARGERS, BATTERY

[NEMA PE 5] [UL 1236] [UL 1564]. Battery chargers shall be general purpose, continuous current output, with solid state rectifiers. Means shall be provided to regulate and to adjust the dc output voltage. Chargers shall have continuous current ratings of 10 to 15 percent higher than battery current outputs based upon an 8-hour discharge.

2.6 CIRCUIT BREAKERS

2.6.1 MOLDED-CASE CIRCUIT BREAKERS

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489and UL 877 for circuit breakers and circuit breaker enclosures located in hazardous (classified) locations. Circuit breakers may be installed in panelboards, switchboards, enclosures, motor control centers, or combination motor controllers.

2.6.1.1 Construction

Circuit breakers shall be suitable for mounting and operating in any position. Lug shall be listed for [copper conductors only] [copper and aluminum conductors] in accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

2.6.1.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with NEMA AB 1. Ratings shall be coordinated with system X/R ratio.

2.6.1.3 Cascade System Ratings

Circuit breakers used in series combinations shall be in accordance with UL 489. Equipment, such as switchboards and panelboards, which house series-connected circuit breakers shall be clearly marked accordingly. Series combinations shall be listed in the UL Recognized Component Directory under "Circuit Breakers-Series Connected."

2.6.1.4 Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above [150] [_____] amperes.

2.6.2 Solid-State Trip Elements

****

NOTE: Delete the last sentence from item g where zone-selective interlocking is not required.

****

Solid-state circuit breakers shall be provided as shown. All electronics shall be self-contained and require no external relaying, power supply, or accessories. Printed circuit cards shall be treated to resist moisture absorption, fungus growth, and signal leakage. All electronics shall be housed in an enclosure which provides protection against arcs, magnetic interference, dust, and other contaminants. Solid-state sensing shall measure true RMS current with error less than one percent on systems with distortions through the 13th harmonic. Peak or average actuating devices are not acceptable. Current sensors shall be torodial construction, encased in a plastic housing filled with epoxy to protect against damage and moisture and shall be integrally mounted on the breaker. Where indicated on the drawings, circuit breaker frames shall be rated for 100 percent continuous duty. Circuit breakers shall have tripping features as shown on the drawings and as described below:

a. Long-time current pick-up, adjustable from 50 percent to 100 percent of continuous current rating.

b. [Fixed] [Adjustable] long-time delay.

c. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.

d. [Fixed] [Adjustable] short-time delay.

e. [Short-time I square times t switch.]

f. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.

g. Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but not greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap will not be permitted. Zone-selective interlocking shall be provided as shown.

h. [Fixed] [Adjustable] ground-fault delay.

i. Ground-fault I square times t switch.

j. [Overload] [and] [short-time] [and] [ground-fault] trip indicators shall be provided.

2.6.3 Current-Limiting Circuit Breakers

Current-limiting circuit breakers shall be provided as shown. Current-limiting circuit breakers shall limit the let-through I square times t to a value less than the I square times t of one-half cycle of the symmetrical short-circuit current waveform. On fault currents below the threshold of limitation, breakers shall provide conventional overload and short-circuit protection. Integrally-fused circuit breakers shall not be used.

2.6.4 SWD Circuit Breakers

Circuit breakers rated 15 amperes and intended to switch 277 volts or less fluorescent lighting loads shall be marked "SWD."

2.6.5 HACR Circuit Breakers

Circuit breakers 60 amperes or below, 240 volts, 1-pole or 2-pole, intended to protect multi-motor and combination-load installations involved in heating, air conditioning, and refrigerating equipment shall be marked "Listed HACR Type."

2.6.6 Low-Voltage Power

****

NOTE: Delete the last sentence from item b.7 where zone-selective interlocking is not required.

****

a. Construction:

Low-voltage power circuit breakers shall conform to IEEE ANSI/IEEE C37.13, ANSI C37.16, and NEMA SG 3 and shall be three-pole, single-throw, stored energy, [manually] [electrically] operated, with drawout mounting.

Solid-state trip elements which require no external power connections shall be provided. Circuit breakers shall have an open/close contact position indicator, charged/discharged stored energy indicator, primary disconnect devices, and a mechanical interlock to prevent making or breaking contact of the primary disconnects when the circuit breaker is closed. Control voltage shall be [24 V dc] [48 V dc] [125 V dc] [120 V dc] [as indicated]. The circuit breaker enclosure shall be suitable for its intended location.

b. Ratings:

Voltage ratings shall be not less than the applicable circuit voltage. Circuit breakers shall be rated for 100 percent continuous duty and shall have trip current ratings and frame sizes as shown. Nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings shall be in accordance with ANSI C37.16. Tripping features shall be as follows:

1. Long-time current pick-up, adjustable from 50 percent to 100 percent of sensor current rating.

2. Adjustable long-time delay.

3. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.

4. Adjustable short-time delay.

5. [Short-time I square times t switch.]

6. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.

7. Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap shall not be permitted. Zone-selective interlocking shall be provided as shown.

8. [Fixed] [Adjustable] ground-fault delay.

9. [Ground-fault I square times t switch.]

10. [Overload] [and] [short-circuit] [and] [ground-fault] trip indicators shall be provided.

2.6.7 Medium-Voltage Circuit Breakers

Medium-voltage circuit breakers shall conform to the requirements specified in Section 16311; MAIN ELECTRIC SUPPLY STATION AND SUBSTATION.

2.6.8 Ground Fault Circuit Interrupters

UL 943. Breakers equipped with ground fault circuit interrupters shall have ground fault class, interrupting capacity, and voltage and current ratings as indicated.

2.7 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

****

NOTE: MSCPs are components of motor controllers rather than fuses. MSCPs, therefore, have no ampere ratings and are identified by letter designations, A-Y. Due to a limited number of MSCP manufacturers, MSCPs should be used only as a sole-source item.
****

Motor short-circuit protectors shall conform to UL 508 and shall be provided as shown. Protectors shall be used only as part of a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection, and shall be rated in accordance with the requirements of NFPA 70.

2.7.1 Construction

Motor short-circuit protector bodies shall be constructed of high temperature, dimensionally stable, long life, nonhygroscopic materials. Protectors shall fit special MSCP mounting clips and shall not be interchangeable with any commercially available fuses. Protectors shall have 100 percent one-way interchangeability within the A-Y letter designations. All ratings shall be clearly visible.

2.7.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Letter designations shall be A through Y for motor controller Sizes 0, 1, 2, 3, 4, and 5, with 100,000 amperes interrupting capacity rating. Letter designations shall correspond to controller sizes as follows:

CONTROLLER SIZE	MSCP DESIGNATION
NEMA O	A-N
NEMA 1	A-P
NEMA 2	A-S
NEMA 3	A-U
NEMA 4	A-W
NEMA 5	A-Y

2.8 CONDUIT AND TUBING

2.8.1 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797

2.8.2 Electrical Nonmetallic Tubing (ENT)

NEMA TC 13.

2.8.3 Electrical Plastic Tubing and Conduit

NEMA TC 2.

2.8.4 Flexible Conduit, Steel and Plastic

General-purpose type, UL 1; liquid tight, UL 360, and UL 1660.

2.8.5 Intermediate Metal Conduit

UL 1242.

2.8.6 PVC Coated Rigid Steel Conduit

NEMA RN 1.

2.8.7 Rigid Aluminum Conduit

ANSI C80.5 and UL 6.

2.8.8 Rigid Metal Conduit

UL 6.

2.8.9 Rigid Plastic

NEMA TC 2, UL 651 and UL 651A.

2.8.10 Surface Metal Electrical Raceways and Fittings

UL 5.

2.9 CONDUIT AND DEVICE BOXES AND FITTINGS

2.9.1 Boxes, Metallic Outlet

NEMA OS 1 and UL 514C.

2.9.2 Boxes, Nonmetallic, Outlet and Flush-Device Boxes and Covers

NEMA OS 2 and UL 514C.

2.9.3 Boxes, Outlet for Use in Hazardous (Classified) Locations

UL 886.

2.9.4 Boxes, Switch (Enclosed), Surface-Mounted

UL 98.

2.9.5 Fittings for Conduit and Outlet Boxes

UL 514B.

2.9.6 Fittings For Use in Hazardous (Classified) Locations

UL 886.

2.9.7 Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

UL 514B.

2.10 CONDUIT COATINGS PLASTIC RESIN SYSTEM

NEMA RN 1, Type A-40.

2.11 CONNECTORS, WIRE PRESSURE

2.11.1 For Use With Copper Conductors

UL 486A.

2.11.2 For Use With Aluminum Conductors

UL 486B.

2.12 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467.

2.12.1 Ground Rods

****

NOTE: Designer will determine the size and type of ground rods to be used based on local conditions, earth resistivity data, and on the size and type of the electrical installation. Copper clad steel rods will be specified for normal conditions. Zinc coated steel or stainless steel rods will be used where low soil resistivities are encountered and galvanic corrosion may occur between adjacent underground metallic masses and the copper clad rods. Stainless steel rods have a longer life than zinc coated steel rods, but their use must be justified based on the higher cost. Rods 15.9 mm (5/8 inch) in diameter and 2.4 meters (8 feet) in length are generally acceptable; however, in rocky soils, 19 mm (3/4 inch) rods will be specified. In high resistivity soils, longer 3 meters (10 feet) or sectional rods may be used to obtain the required resistance to ground. Coordinate and standardize rod selection for individual facilities with other specification sections.

****

Ground rods shall be of [copper-clad steel conforming to UL 467] [zinc-coated steel conforming to ANSI C135.30] [solid stainless steel] not less than [5/8] [3/4] inch in diameter by [8] [10] feet in length of the sectional type driven full length into the earth.

2.12.2 Ground Bus

The ground bus shall be bare conductor or flat copper in one piece, if practicable.

2.13 ENCLOSURES

NEMA ICS 6 [or NEMA 250] [or UL 698 for use in hazardous (classified) locations,] unless otherwise specified.

2.13.1 Cabinets and Boxes

Cabinets and boxes with volume greater than 100 cubic inches shall be in accordance with UL 50, hot-dip, zinc-coated, if sheet steel.

2.13.2 Circuit Breaker Enclosures

UL 489.

2.13.3 Circuit Breaker Enclosures for Use in Hazardous (Classified) Locations

UL 877.

2.14 FIXTURES, LIGHTING AND FIXTURE ACCESSORIES/COMPONENTS

Standard Drawing 40-06-04 sheets referenced hereinafter and enclosed as an integral part of these specifications, additional fixtures shown on contract drawings, if any, and UL 844 for fixtures to be installed in hazardous (classified) locations. Fixtures, accessories and components, including ballasts, lampholders, lamps, starters and starter holders, shall conform to industry standards specified below.

2.14.1 Fixture, Auxiliary or Emergency

UL 924.

2.14.2 Incandescent Fixture

NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1571.

2.14.3 Fluorescent

a. Fixture: NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1570. Fixtures shall be plainly marked for proper lamp and ballast type to identify lamp diameter, wattage, color and start type. Marking shall be readily visible to service personnel, but not visible from normal viewing angles.

b. Ballasts:

(1) Magnetic ballast, energy-saving, high power factor, Class P, automatic-resetting Type, approved for the application by the Certified Ballast Manufacturers: ANSI C82.1 and UL 935. Two-lamp ballasts shall be used for each pair of lamps within a fixture or within continuous mounted fixtures. Single-lamp ballasts shall be used for individually mounted single-lamp fixtures and where an odd single-lamp fixture occurs at the end of a continuous group. Magnetic fluorescent lamp ballasts shall have a Ballast Efficacy Factor (BEF) not less than shown in the following table:

MAGNETIC FLUORESCENT BALLAST EFFICACY FACTORS*

Design starting temperature above 40 degrees F with 60 Hz input frequency

NUMBER OF LAMPS	LAMP TYPE	NOMINAL OPERATIONAL INPUT VOLTAGE	MAX. LAMP OPERATING CURRENT	MIN. BALLAST EFFICACY FACTOR
1	4 ft	120	less than	1.805

MAGNETIC FLUORESCENT BALLAST EFFICACY FACTORS*

Design starting temperature above 40 degrees F with 60 Hz input frequency

NUMBER OF LAMPS	LAMP TYPE rapid start	NOMINAL OPERATIONAL INPUT VOLTAGE or 277	MAX. LAMP OPERATING CURRENT 1000 m amp	MIN. BALLAST EFFICACY FACTOR
2	4 ft rapid start	120	less than 1000 m amp	1.060
2	4 ft rapid start	277	less than 1000 m amp	1.050
2	8 ft slim-line	120 - 277	less than 1000 m amp	0.570
2	8 ft high output, rapid start	120 - 277	less than 1000 m amp	0.390

* For ballasts not specifically designed for use with dimming controls

The BEF is calculated using the formula:

BEF = Ballast Factor, (in percent) / Power Input

Where Power Input = Total Wattage of Combined Lamps and Ballasts.

(2) Electronic Ballast. Electronic ballasts shall consist of a rectifier, high frequency inverter, and power control and regulation circuitry. The ballasts shall be UL listed, Class P, with a Class A sound rating and shall contain no PCBs. Ballasts shall meet 47 CFR 18 for electromagnetic interference and shall not interfere with the operation of other electrical equipment. Design shall withstand line transients per IEEE C62.41, Category A. Unless otherwise indicated, the minimum number of ballasts shall be used to serve each individual fixture, using one, two, three or four lamp ballasts. A single ballast may be used to serve multiple fixtures if they are continuous mounted, factory manufactured for that installation with an integral wireway, and are identically controlled.

(a) Light output regulation shall be +/- 10%.

(b) Voltage input regulation shall be +/- 10%.

(c) Lamp current crest factor shall be no more than 1.6.

(d) Ballast factor shall be not less than 85% nor more than 100%, unless otherwise indicated.

(e) A 60 Hz filter shall be provided. Flicker shall be no more than 10% with any lamp suitable for the ballast.

(f) Ballast case temperature shall not exceed 25 degree Celsius rise above 40 degree Celsius ambient, when tested in accordance with UL 935.

(g) Total harmonic distortion shall be in the range of 10-20%.

(h) Power factor shall not be less than 0.95.

(i) Ballasts shall operate at a frequency of 20 kHz or more.

(j) Operating filament voltage shall be 2.5 to 4.5 volts.

(k) Warranty. Three year full warranty including a $10 labor allowance.

(l) Ballast Efficacy Factor (BEF) shall be in accordance with the following table. Ballasts and lamps shall be matching rapid start or instant start as indicated on the following table. If 32W-F32-T8 lamps and ballasts are used, they must be either all rapid start or all instant start.

ELECTRONIC FLUORESCENT BALLAST EFFICACY FACTORS*

LAMP TYPE	TYPE OF STARTER & LAMP	NOMINAL OPERATIONAL INPUT VOLTAGE	NUMBER OF LAMPS	MIN. BALLAST EFFICACY FACTOR
40W F40 T12	rapid start	120 or 277 V	1	2.3
			2	1.2
			3	0.8
			4	0.6
34W F40 T12	rapid start	120 or 277 V	1	2.6
			2	1.3
			3	1.0
			4	0.7
40W F40 T10	rapid start	120 or 277 V	1	2.2
			2	1.1
			3	0.8
32W F32 T8	rapid or instant start	120 or 277 V	1	2.4
			2	1.4
			3	1.0
			4	0.8

*For ballasts not specifically designed for use with dimming controls

The BEF is calculated using the formula:

BEF = Ballast Factor (in percent) / Power Input

Where Power Input = Total Wattage of Combined Lamps and Ballasts.

c. Lampholders, Starters, and Starter Holders: UL 542.

2.14.4 High-Intensity-Discharge

a. Fixture: NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1572.

b. Ballasts: ANSI C82.4 for multiple supply types and UL 1029.

2.15 LOW-VOLTAGE FUSES AND FUSEHOLDERS

2.15.1 Fuses, Low Voltage Cartridge Type

NEMA FU 1.

2.15.2 Fuses, High-Interrupting-Capacity, Current-Limiting Type

Fuses, Class G, J, L and CC shall be in accordance with UL 198C.

2.15.3 Fuses, Class K, High-Interrupting-Capacity Type

UL 198D.

2.15.4 Fuses, Class H

UL 198B.

2.15.5 Fuses, Class R

UL 198E.

2.15.6 Fuses, Class T

UL 198H.

2.15.7 Fuses for Supplementary Overcurrent Protection

UL 198G.

2.15.8 Fuses, D-C for Industrial Use

UL 198L.

2.15.9 Fuseholders

UL 512.

2.16 INSTRUMENTS, ELECTRICAL INDICATING

ANSI C39.1.

2.17 MOTORS, AC, FRACTIONAL AND INTEGRAL

****

NOTE: Determine if motors must be standard or high efficiency type based on the number of expected operating hours. Standard efficiency will be used

when the expected annual operating hours are 750 hours or less. Otherwise high efficiency motors will be used. For each application, the efficiency type must be indicated in the contract documents.
****

Motors, ac, fractional and integral horsepower, 500 hp and smaller shall conform to NEMA MG 1 and UL 1004for motors; NEMA MG 10 for energy management selection of polyphase motors; and UL 674 for use of motors in hazardous (classified) locations.

2.17.1 Rating

The horsepower rating of motors should be limited to no more than 125 percent of the maximum load being served unless a NEMA standard size does not fall within this range. In this case, the next larger NEMA standard motor size should be used.

2.17.2 Motor Efficiencies

All permanently wired polyphase motors of 1 hp or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 1 hp or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

Minimum Motor Efficiencies

HP	Std. Efficiency	High Efficiency
1	77.0	85.5
1.5	78.5	85.5
2	78.5	85.5
3	78.5	88.5
5	82.5	88.5
7.5	84.0	90.0
10	85.5	90.0
15	85.5	91.0
20	87.5	92.0
25	88.5	92.0
30	88.5	92.0
40	88.5	92.0
50	89.0	92.5
60	89.0	92.5
75	89.0	95.5
100	90.0	93.5
125	91.0	94.5
150	91.0	94.5
200	91.0	94.5
250	91.0	94.5
300	91.0	94.5
350	91.0	94.5
400	91.0	94.5
500	91.0	94.5

2.18 MOTOR CONTROLS AND MOTOR CONTROL CENTERS

2.18.1 General

NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845. Panelboards supplying non-linear loads shall have neutrals sized for 200 percent of rated current.

2.18.2 Motor Starters

Combination starters shall be provided with [circuit breakers,] [and] [fusible switches,] [and] [switches equipped with high-interrupting-capacity current-limiting fuses] [as indicated].

2.18.2.1 Reduced-Voltage Starters

****

NOTE: Reduced voltage starters will be required when the locked rotor current of motors exceeds the full-load of supply transformers or supply conductors.

****

Reduced-voltage starters shall be provided for polyphase motors [_____] hp or larger. Reduced-voltage starters shall be of the single-step autotransformer, reactor, or resistor type having an adjustable time interval between application of reduced and full voltages to the motors. Wye-delta reduced voltage starter or part winding increment starter having an adjustable time delay between application of voltage to first and second winding of motor may be used in lieu of the reduced voltage starters specified above for starting of motor-generator sets, centrifugally operated equipment or reciprocating compressors provided with automatic unloaders.

2.18.3 Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

2.18.4 Low-Voltage Motor Overload Relays

****

NOTE: In most cases, thermal relays will be specified. Standard, slow, and quick-acting trip units are available. Magnetic relays are used to protect low-voltage motors with starting times or unusual duty cycles.

****

2.18.4.1 General

[Thermal] [and] [magnetic current] overload relays shall conform to NEMA ICS 2 and UL 508. Overload protection shall be provided either integral with the motor or motor controller, and shall be rated in accordance with the requirements of NFPA 70. [Standard units shall be used for motor starting times up to 7 seconds.] [Slow units shall be used for motor starting times from 8 to 12 seconds.] [Quick trip units shall be used on hermetically sealed, submersible pumps, and similar motors.]

2.18.4.2 Construction

Manual reset type thermal relay shall be [melting alloy] [bimetallic] construction. Automatic reset type thermal relays shall be bimetallic construction. Magnetic current relays shall consist of a contact mechanism and a dash pot mounted on a common frame.

2.18.4.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise, and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly varies by more than minus 18 degrees F, an ambient temperature-compensated overload relay shall be provided.

2.18.5 Automatic Control Devices

2.18.5.1 Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall be designed for that purpose and have an adequate horsepower rating.

2.18.5.2 Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

2.18.5.3 Manual/Automatic Selection

a. Where combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch (marked MANUAL-OFF-AUTOMATIC) shall be provided for the manual control.

b. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC.

c. Connections to the selector switch shall be such that; only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low-or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

2.18.6 Motor Control Centers

Control centers shall conform to the requirements of NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845. Control centers shall be indoor type and shall contain combination starters and other equipment as indicated. Control centers shall be NEMA ICS 2, Class [_____], Type [_____]. Each control center shall be mounted on floor sills or mounting channels. Each circuit shall have a suitable metal or laminated plastic nameplate with white cut letters. Motor control centers shall be provided with a full-length ground bus bar.

2.19 PANELBOARDS

Dead-front construction, NEMA PB 1 and UL 67.

2.20 RECEPTACLES

****

NOTE: Select the proper grade for the application. Heavy duty grade receptacles are to be specified if heavy use is known or can be reasonably predicted. Standard grade should be specified if normal use is known or is obvious by the functional use of the areas. Specify the NEMA configurations for each receptacle type required; delete the types not used.

****

2.20.1 Hospital Grade

UL 498.

2.20.2 Heavy Duty Grade

NEMA WD 1. Devices shall conform to all requirements for heavy duty receptacles.

2.20.3 Standard Grade

UL 498.

2.20.4 Ground Fault Interrupters

UL 943, Class A or B.

2.20.5 Hazardous (Classified) Locations

UL 1010.

2.20.6 NEMA Standard Receptacle Configurations

NEMA WD 6.

a. Single and Duplex, 15-Ampere and 20-Ampere, 125 Volt

15-ampere, non-locking: NEMA type 5-15R, locking: NEMA type L5-15R, 20-ampere, non-locking: NEMA type 5-20R, locking: NEMA type L5-20R.

b. 15-Ampere, 250 Volt

Two-pole, 3-wire grounding, non-locking: NEMA type 6-15R, locking: NEMA type L6-15R. Three-pole, 4-wire grounding, non-locking: NEMA type 15-15R, locking: NEMA type L15-15R.

c. 20-Ampere, 250 Volt

Two-pole, 3-wire grounding, non-locking: NEMA type 6-20R, locking: NEMA type L6-20R. Three-pole, 4-wire grounding, non-locking: NEMA type 15-20R, locking: NEMA type L15-20R.

d. 30-Ampere, 125/250 Volt

Three-pole, 3-wire, non-locking: NEMA type 10-30R, locking: NEMA type L10-30R. Three-pole, 4-wire grounding, non-locking: NEMA type 14-30R, locking: NEMA type L14-30R.

e. 30-Ampere, 250 Volt

Two-pole, 3-wire grounding, non-locking: NEMA type 6-30R, locking: NEMA type L6-30R. Three-pole, 4-wire grounding, non-locking: NEMA type 15-30R, locking: NEMA type L15-30R.

f. 50-Ampere, 125/250 Volt

Three-pole, 3-wire: NEMA type 10-50R. Three-pole, 4-wire grounding: NEMA type 14-50R.

g. 50-Ampere, 250 Volt

Two-pole, 3-wire grounding: NEMA type 6-50R. Three-pole, 4-wire grounding: NEMA type 15-50R.

2.21 Service Entrance Equipment

UL 869A.

2.22 SPLICE, CONDUCTOR

UL 486C.

2.23 POWER-SWITCHGEAR ASSEMBLIES INCLUDING SWITCHBOARDS

****

NOTE: Interrupting capacities of molded-case circuit breakers will be in accordance with UL 489. Unless otherwise approved, a 125 Volt dc power source will be shown and specified to ensure proper closing and tripping of protective devices which require a reliable power source during outage of the normal alternating-current power source.

****

Assemblies shall be metal-enclosed, freestanding general-purpose [type] [ventilated type] in accordance with NEMA PB 2, UL 891, and IEEE ANSI/IEEE C37.20.1 and shall be installed to provide front and rear access. Busses shall be [copper] [aluminum]. Assembly shall be approximately 90 inches high; arrangement of circuit breakers and other items specified shall be as indicated. The withstand rating and interrupting capacity of the [switchgear] [switchboards] and [circuit breakers] [fuses] shall be based on the maximum fault current available.

2.23.1 Circuit Breakers

****

NOTE: Drawout type circuit breakers are the preferred configuration when low and medium voltage power circuit breakers, and insulated case type circuit breakers are used. These type breakers are preferred because they are easier to maintain and have a higher reliability than the other types. Delete last option when drawout type compartments are not required.

****

Circuit breakers shall be [stationary] [drawout] [medium-voltage power circuit breakers] [low-voltage power circuit breakers] [molded-case circuit breakers] [molded-case circuit breakers coordinated with current-limiting fuses] [insulated-case, systems type circuit breakers] [4-position drawout type circuit breaker compartments with cell switches for connected, test; disconnected and withdrawn positions].

2.23.2 Auxiliary Equipment

2.23.2.1 Instruments

Instruments shall be long scale, 6.8 inches minimum, semiflush rectangular, indicating or digital switchboard type, mounted at eye level.

a. Ammeter, range 0 to [_____] amperes, complete with selector switch having off position and positions to read each phase current.

b. Voltmeter, range 0 to [_____] volts, complete with selector switch having off position and positions to read each phase [to phase] [to neutral] voltage.

2.23.2.2 Control Switch

A control switch with indicating lights shall be provided for each electrically operated breaker.

2.23.2.3 Control Power Sources

Control buses and control power transformers shall conform to the requirements of Section 16311 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION, where required. Control power shall be [125-volt DC] [48-volt DC] [120-volt AC] [_____].

2.24 SNAP SWITCHES

UL 20.

2.25 TAPES

2.25.1 Plastic Tape

UL 510.

2.25.2 Rubber Tape

UL 510.

2.26 TRANSFORMERS

****

NOTE: Select transformer impedance required for each transformer and indicate on drawings. For most projects, the manufacturer's standard impedance is sufficient. Designer is responsible for ensuring that the available fault current and the means to accommodate that fault current, such as higher impedance, higher rated protective devices, current limiting fuses, etc., are provided.

****

Single- and three-phase transformers shall have two windings per phase. Full-capacity standard NEMA taps shall be provided in the primary windings of transformers unless otherwise indicated. Three-phase transformers shall be configured with [delta-wye] [wye-delta] windings, except as indicated. "T" connections may be used for transformers rated 15 kVA or below. Transformers supplying non-linear loads shall be UL listed as suitable for supplying such loads with a total K-factor not to exceed K-[9] [13] [_____] and have neutrals sized for 200 percent of rated current.

2.26.1 Transformers, Dry-Type

****

NOTE: Delete the requirement for epoxy-resin cast coil construction where not required.

****

Transformers shall have 220 degrees C insulation system for transformers 15 kVA and greater, and shall have 180 degrees C insulation system for transformers rated 10 kVA and less, with temperature rise not exceeding [150] [115] [80] degrees C under full-rated load in maximum ambient temperature of 40 degrees C. [Transformer of 150 degrees C temperature rise shall be capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating.] [Transformer of 115 degrees C temperature rise shall be capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating.] [Transformer of 80 degrees C temperature rise shall be capable of carrying continuously 130 percent of nameplate kVA without exceeding insulation rating.]

a. 600 Volt or Less Primary:

NEMA ST 20, UL 506, general purpose, dry-type, self-cooled, [ventilated] [unventilated] [sealed] [epoxy-resin cast coil,]. Transformers shall be provided in NEMA [1] [3R] [_____] enclosure. Transformers shall be quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

b. 601 to 34,500 Volt Primary:

(1) Distribution: Ventilated, [epoxy-resin cast coil,] 1 to 500 kVA, single phase, and 15 to 500 kVA, three-phase, low-voltage 120-600 volts: ANSI C57.12.50.

(2) Power: Ventilated, [epoxy-resin cast coil,] 501 kVA and larger, three-phase, low-voltage 208Y/120 to 4160 volts: ANSI C57.12.51.

(3) Power: Sealed, [epoxy-resin cast coil,] 501 kVA and larger, three-phase, low-voltage 208Y/120 to 4160 volts: ANSI C57.12.52.

2.26.2 Liquid-Insulated Transformers

IEEE ANSI/IEEE C57.12.00, ANSI C57.12.10, ANSI C57.12.13, ANSI C57.12.27, ANSI C57.12.70, IEEE ANSI/IEEE C57.12.80, IEEE ANSI/IEEE C57.12.90, IEEE ANSI/IEEE C57.98, and IEEE ANSI/IEEE C57.100. Transformers may be the mineral-oil insulated, silicone, or the high-molecular weight hydrocarbon (HMWH) type. Voltage and KVA ratings shall be as indicated. Pressure relief valves and relays required for safe operation in an interior location or vault shall be provided. [Single kVA ratings shown are based on self-cooled operation.] [Dual kVA ratings require that transformers be equipped for forced air cooling. Forced air cooling shall include the fans and controls necessary to operate the fans when the self-cooling temperature rating is attained.] [Transformers rated above 300 kVA shall be equipped with features to permit the future addition of cooling fans, controls, and wiring.] Temperature rise shall not exceed [55/65] [_____] degrees C under full load operation in an ambient temperature of 40 degrees C. Percent voltage impedance shall be [_____] [manufacturer's standard] [as required to limit the available fault current to less than the withstand rating of the equipment fed by the transformer]. The basic impulse insulation level (BIL) rating shall be not less than [95] [110] [125] [_____] kV for the distribution voltage shown. Nameplates shall be provided in accordance with IEEE ANSI/IEEE C57.12.00.

2.26.3 Average Sound Level

The average sound level in decibels (dB) of transformers shall not exceed the following dB level at 12 inches for the applicable kVA rating range listed unless otherwise indicated:

kVA Range	dB Sound Level
1-50	50
51-150	55
151-300	58
301-500	60
501-700	62
701-1000	64
1001-1500	65
1501 & above	70

2.27 ISOLATED POWER SYSTEM EQUIPMENT

UL 1047, with monitor UL 1022.

2.28 WATTHOUR METERS, UTILITY REVENUE

****

NOTE: Delete this paragraph unless the Using Service criteria requires the metering of the watthours consumed on a monthly basis. In that event, include the paragraph but modify it to suit the functional requirements of the Using Service relative to watthour demand, pulse initiators, meter mounting, etc.

****

Watthour meters shall conform to ANSI C12.1 and ANSI C12.10, except numbered terminal wiring sequence and case size may be the manufacturer's standard. Watthour meters shall be of the [drawout switchboard type] [socket-mounted [outdoor] [indoor] type] having a 15-minute, cumulative form, demand register meeting ANSI C12.4 and provided with not less than two and one-half stators. Watthour demand meters shall have factory-installed electronic pulse initiators meeting the requirements of ANSI C12.1. Pulse initiators shall be solid-state devices incorporating light-emitting diodes, phototransistors, and power transistors, except that mercury-wetted output contacts are acceptable. Initiators shall be totally contained within watthour demand meter enclosures, shall be capable of operating up to speeds of 500 pulses per minute with no false pulses, and shall require no field adjustments. Initiators shall be calibrated for a pulse rate output of one pulse per 1/4 disc revolution of the associated meter and shall be compatible with the indicated equipment.

2.29 WATTHOUR/DEMAND METERS, CHECK

****

NOTE: Check metering is customer-supplied metering in addition to the utility revenue metering for the purpose of monitoring energy demand and efficiency. Check metering shall be provided for buildings and facilities (both new construction and retrofit projects) where the demand exceeds 150 kVA. Meter the following individually where system demand exceeds 100 kVA:

a. Production processes (manufacturing, computers, laundries, kitchens)
b. Auxiliary systems and service water heating
c. Space heating (including reheat)
d. Space cooling
e. HVAC delivery systems

Watthour-demand meters shall be provided with interface to permit remote monitoring of instantaneous demand. Designer shall select location of meters and indicate on drawings. Select watthour meter if watthour-demand meter is not required.

****

ANSI C12.10 for self-contained [watthour] [watthour-demand] meter with pulse-initiators for remote monitoring of watt-hour usage [and instantaneous demand]. [Meter shall be drawout switchboard type.] [Meter shall be socket-mounted [outdoor] [indoor] type.] Meter shall be Class [100] [200] [as indicated].

2.30 INSTRUMENT TRANSFORMERS

2.30.1 General

Instrument transformers shall comply with ANSI C12.11 and IEEE ANSI/IEEE C57.13. Instrument transformers shall be configured for mounting in/on the device to which they are applied. Polarity marks on instrument transformers shall be visually evident and shown on drawings.

2.30.2 Current Transformers

****

NOTE: See TM 5-811-1 AFJMAN 32-1080 regarding guidance on current transformers. Accuracy class ratings of current transformers (CTs) at standard burdens are listed in IEEE ANSI/IEEE C57.13. In general, ANSI C12.11 requires a 0.3 accuracy class for up to a B-0.5 burden, except for some 200 and 400 ampere units. Where metering current transformers are provided, this accuracy class should be specified, if available for the ampere rating and burden needed. A "C" classification means the ratio error can be calculated, whereas a "T" classification is one which has to be derived by testing. ANSI C37.20.2 permits either classification up to the indicated ratings.

****

Unless otherwise indicated, bar, wound, or window-type transformers are acceptable; and except for window-type units installed over insulated buses, transformers shall have a BIL rating consistent with the rated BIL of the associated switchgear or electric power apparatus bushings, buses or conductors. Current transformers shall have the indicated ratios. The continuous thermal-current rating factor shall be not less than [1.0] [1.2] [1.5] [2.0] [3.0] [4.0]. Other thermal and mechanical ratings of current transformer and their primary leads shall be coordinated with the design of the circuit breaker and shall be not less than the momentary rating of the associated circuit breaker. Circuit protectors shall be provided across secondary leads of the current transformers to prevent the accidental open-circuiting of the transformers while energized. Each terminal of each current transformer shall be connected to a short-circuiting terminal block in the circuit interrupting mechanism cabinet, power transformer terminal cabinet, and in the associated instrument and relay cabinets.

2.30.2.1 Current Transformers for Power Transformers

****

NOTE: ANSI C57.12.10, Table 20 gives recommended values.

****

[Single-ratio] [Multi-ratio] bushing type current transformers shall be provided internally around power transformer bushings as shown. [Single-ratio units shall have a minimum metering accuracy class of [0.6B-0.5] [0.3B-0.5].] [Multi-ratio units shall have a minimum relaying accuracy voltage class of [_____] for either a C or T classification.]

2.30.2.2 Current Transformers for Metal-Enclosed Switchgear

Single-ratio units, used for metering and relaying, shall have a metering accuracy class rating of [_____] [B._____]. Single-ratio units, used only for relaying, shall have a relaying accuracy class rating of [_____] for [either] a C [or T] classification.

2.30.2.3 Current Transformers for Metal-Clad Switchgear

Single-ratio units, used for metering and relaying, shall have a metering accuracy class rating of [_____] [B._____]. Single-ratio units, used only for relaying, shall have a relaying accuracy class rating of [_____] for [either] a C [or T] classification.

2.30.2.4 Current Transformers for kWH and Demand Metering (Low Voltage)

****

NOTE: Use the following guidelines for specifying current transformers, etc.

1. Select the standard current transformer (CT) primary rating which is just below the full load current of the serving power transformer, service entrance, etc., for example, for a 500 kVA transformer with a full load of 1387 amps at 208 volts - select a 1200/5 CT ratio; for a 750 kVA transformer with a full load of 902 amps at 480 volts - select a 800/5 CT ratio.

2. Select a continuous-thermal-current rating factor (RF) in accordance with the following table:

RATIO	**RF at 30 degrees C**
200/5	**4.0**
300/5	**3.0**
400/5	**4.0**
600/5	**3.0**
800/5	**2.0**
1200/5	**1.5**
1500/5	**1.5**
2000/5	**1.5**
3000/5	**1.33**

3. Select an ANSI Metering Accuracy Class in accordance with the following Table:

Primary Amp Rating (of CT)	Accuracy Class
200	**0.3 thru B-0.1**
300-400	**0.3 thru B-0.2**
600-1200	**0.3 thru B-0.5**
1500	**0.3 thru B-0.9**
2000-3000	**0.3 thru B-1.8**

****

Current transformers shall conform to IEEE ANSI/IEEE C57.13. Provide current transformers with a metering accuracy Class of 0.3 through [_____], with a minimum RF of [_____] at 30 degrees C, with 600-volt insulation, and 10 kV BIL. Provide butyl-molded, window-type current transformers mounted [on the transformer low-voltage bushings. Route current transformer leads in a location as remote as possible from the power transformer secondary cables to permit current measurements to be taken with hook-on-ammeters.] [in the current transformer cabinet.]

2.30.2.5 Voltage Transformers

****

NOTE: See TM 5-822-1 for guidance regarding voltage transformers. Minimum standard potential transformer accuracies for metal-clad switchgear are not listed in ANSI C37.20.2. Accuracy classes as listed in IEEE ANSI/IEEE C57.13 are 0.3, 0.6, and 1.2. Standard burdens for each accuracy class are W, X, Y, Z, ZZ, and M. The designer should check the burdens connected to determine the actual accuracy class and burden required. In general, ANSI C12.11 requires 0.3 accuracy class up to Y burdens, except for voltages of 5 kV and below. Where metering potential transformers are provided, a 0.3 accuracy class should be specified, if available for the voltage rating and burden needed.

****

Voltage transformers shall have indicated ratios. Units shall have an accuracy class rating of [_____]. Voltage transformers shall be of the drawout type having current-limiting fuses in both primary and secondary circuits. Mechanical interlocks shall prevent removal of fuses, unless the associated voltage transformer is in a drawout position. Voltage transformer compartments shall have hinged doors.

2.31 WIRING DEVICES

NEMA WD 1 for wiring devices, and NEMA WD 6 for dimensional requirements of wiring devices.

2.32 Liquid-Dielectrics

****

NOTE: Select 2 ppm for Air Force projects.

****

Liquid dielectrics for transformers, capacitors, and other liquid-filled electrical equipment shall be non-polychlorinated biphenyl (PCB) mineral oil or less flammable liquid as specified. Nonflammable fluids shall not be used. Tetrachloroethylene (perchloroethylene) and 1, 2, 4 trichlorobenzene fluids shall be certified by the manufacturer as having less than [50] [2] parts per million (ppm) PCB content. In lieu of the manufacturer's certification, the Contractor may submit a test sample of the dielectric in accordance with ASTM D 4059 at a testing facility approved by the Contracting Officer. Equipment with test results indicating PCB level exceeding [50] [2] ppm shall be replaced.

2.33 COORDINATED POWER SYSTEM PROTECTION

****

NOTE: The requirement for studies in this section depends on the complexity and extent of the power system. Delete this requirement for projects of limited scope, projects having protective devices which are not adjustable or for which coordination is not possible (standard molded case circuit breakers); projects involving simple extension of 600 volt level service to a building or facility from an existing transformer (750 kVA or less); or projects involving simple extension of 600 volt level service to a building or facility from a new transformer (750 kVA or less).

The designer will be responsible for showing and specifying the requirements for fuses, circuit breakers, protective relays, or other protective devices associated with the project. The protective devices should be selected and specified to protect electrical power system conductors or equipment against sustained overloads, in-rush conditions, electrical faults, or other abnormal power system or equipment operating conditions, in accordance with TM 5-811-14, and IEEE Std 242, and IEEE Std 141.

The complexity and extent of coordinated power system protection depends on the type of buildings or facilities or utilities required, on the load demand of facilities, and on the quantity and types of facilities to be constructed. Facilities having a relatively-low power demand (e.g., 2,500 kVA or less) generally require protection of an incoming aerial distribution line or underground, medium-voltage feeder; low-voltage feeders to individual items of equipment, or to power distribution equipment; and branch circuits. More complex projects such as facilities with generating capacity, large motors, or larger load demands, will require more detailed and extensive coordinated power system protection.

Independent of the type or types of facilities or load demands, the coordinated power system

protection will be based on: economics, simplicity, and the electrical power availability dictated by the Using Agency or Service, or by the functional use of the facilities or utilities; required to provided maximum power service with a minimum of power interruptions; and the operating speed of protective devices required to minimize damage to electrical components or items of equipment and to prevent injury to personnel and nuisance tripping.

Unless otherwise approved, a dc power source will be shown and specified to ensure proper closing and tripping of protective devices which require a reliable power during outage of the normal alternating-current power source.

****

Analyses shall be prepared to demonstrate that the equipment and system constructed meet the specified requirements for equipment ratings, coordination, and protection. They shall include a load flow analysis, a fault current analysis, and protective device coordination study. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last three years. The Contractor shall provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

2.33.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: [the source bus and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses] [the source bus and extended through the secondary side of transformers for medium voltage distribution feeders.] [the source bus and extend through [outgoing breakers] [outgoing medium voltage feeders, down to the individual protective devices for medium voltage radial taps] [outgoing medium voltage feeders, through the secondary side of transformers] [as indicated] for main electric supply substations.] [the nearest upstream device in the existing source system and extend through the downstream devices at the load end.]

2.33.2 Determination of Facts

****

NOTE: Require the Contractor to obtain an available fault capacity at the power source or provide a fault capacity on which he is to base his analysis. Delete the unused option.

****

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. [The Contractor shall coordinate with the [commercial power company] [_____] for fault current availability at the site.] [The Contractor shall utilize the fault current availability indicated as a basis for fault current studies.]

2.33.3 Single Line Diagram

A single line diagram shall be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformation point shall have a unique identifier. If a fault-impedance diagram is provide, impedance data shall be shown. Locations of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

2.33.4 Fault Current Analysis

2.33.4.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE Std 242, and IEEE Std 399.

2.33.4.2 Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedances shall be those proposed. Data shall be documented in the report.

2.33.4.3 Fault Current Availability

Balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.

2.33.5 Coordination Study

The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study shall include a description of the coordination of the protective devices in this project. Provide a written narrative that describes: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situation where system coordination is not achievable due to device limitations (an analysis of any device curves which order overlap); coordination between upstream and downstream devices; and relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost changes (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

2.33.6 Study Report

a. The report shall include a narrative: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.

b. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.

c. The report shall document utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device curves and protective device ratings and settings.

d. The report shall contain fully coordinated composite time-current characteristic curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.

e. The report shall provide the calculations performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided.

PART 3 EXECUTION

3.1 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following specifications.

3.1.1 Ground Rods

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, [_____] additional rods not less than 6 feet on centers, or if sectional type rods are used, [_____] additional sections may be coupled and driven with the first rod. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

3.1.2 Ground Bus

Ground bus shall be provided in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of [transformer neutrals and other electrical] [electrical] equipment shall be effectively grounded by bonding to the ground bus. The ground bus shall be bonded to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Connections and splices shall be of the brazed, welded, bolted, or pressure-connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment. For raised floor equipment rooms in computer and data processing centers, a minimum of 4, one at each corner, multiple grounding systems shall be furnished. Connections shall be bolted type in lieu of thermoweld, so they can be changed as required by additions and/or alterations.

3.1.3 Grounding Conductors

****

NOTE: Delete the first sentence of the following paragraph except for all Air Force projects or other

special projects justifying a separate ground wire in all conduits. Delete the last sentence when isolated grounding receptacle circuits are used.

****

[A green equipment grounding conductor, sized in accordance with NFPA 70 shall be provided, regardless of the type of conduit. Equipment grounding bars shall be provided in all panelboards. The equipment grounding conductor shall be carried back to the service entrance grounding connection or separately derived grounding connection.] All equipment grounding conductors, including metallic raceway systems used as such, shall be bonded or joined together in each wiring box or equipment enclosure. Metallic raceways and grounding conductors shall be checked to assure that they are wired or bonded into a common junction. Metallic boxes and enclosures, if used, shall also be bonded to these grounding conductors by an approved means per NFPA 70. [When boxes for receptacles, switches, or other utilization devices are installed, any designated grounding terminal on these devices shall also be bonded to the equipment grounding conductor junction with a short jumper.]

3.2 WIRING METHODS

****

NOTE: Where non-linear loads such as computers, laser printers, electronic ballasts, uninterruptible power supplies, adjustable speed drives, etc., constitute 20 percent or more of the total connected load of a transformer, designer will conduct a harmonic analysis study and provide details for harmonic compensation in accordance with IEEE Std 519 and IEEE Std 1100. Harmonic compensation may include, but is not limited to: specifying K-factor rated transformers, derating transformers, oversizing neutrals to 200 percent of the ampacity of phase conductors or phase bus, using phase conductor and terminals with higher ampacities and/or higher temperature ratings, supplying non-linear loads from a dedicated isolation transformer, and installing shunt filters.

Select type of conduit(s) to be used and delete other conduit options.

****

Wiring shall conform to NFPA 70, the contract drawings, and the following specifications. Unless otherwise indicated, wiring shall consist of insulated conductors installed in [rigid aluminum conduit] [rigid zinc-coated steel conduit] [rigid plastic conduit] [electrical metallic tubing] [electrical nonmetallic tubing] [intermediate metal conduit] [[_____] conduit]. Where cables and wires are installed in cable trays, they shall be of the type permitted by NFPA 70 for use in such applications. [Nonmetallic-sheathed cables or metallic-armored cables may be installed in areas permitted by NFPA 70.] Wire fill in conduits shall be based on NFPA 70 for the type of conduit and wire insulations specified. Wire fill in conduits located in Class I or II hazardous areas shall be limited to 25 percent of the cross sectional area of the conduit.

3.2.1 Conduit and Tubing Systems

Conduit and tubing systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 1/2 inch. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. Nonmetallic conduit and tubing may be used in damp, wet or corrosive locations when permitted by NFPA 70 and the conduit or tubing system is provided with appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Electrical metallic tubing (EMT) may be installed only within buildings. EMT may be installed in concrete and grout in dry locations. EMT installed in concrete or grout shall be provided with concrete tight fittings. EMT shall not be installed in damp or wet locations, or the air space of exterior masonry cavity walls. Bushings, manufactured fittings or boxes providing equivalent means of protection shall be installed on the ends of all conduits and shall be of the insulating type, where required by NFPA 70. Only UL listed adapters shall be used to connect EMT to rigid metal conduit, cast boxes, and conduit bodies. Aluminum conduit may be used only where installed exposed in dry locations. Nonaluminum sleeves shall be used where aluminum conduit passes through concrete floors and firewalls. Penetrations of above grade floor slabs, time-rated partitions and fire walls shall be firestopped in accordance with Section 07270 FIRESTOPPING. Except as otherwise specified, IMC may be used as an option for rigid steel conduit in areas as permitted by NFPA 70. Raceways shall not be installed under the firepits of boilers and furnaces and shall be kept 6 inches away from parallel runs of flues, steam pipes and hot-water pipes. Raceways shall be concealed within finished walls, ceilings, and floors unless otherwise shown. Raceways crossing structural expansion joints or seismic joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding. Wiring installed in [underfloor duct system] [underfloor raceway system] shall be suitable for installation in wet locations.

3.2.1.1 Pull Wires

A pull wire shall be inserted in each empty raceway in which wiring is to be installed if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 200 pounds per square inch tensile strength. Not less than 10 inches of slack shall be left at each end of the pull wire.

3.2.1.2 Conduit Stub-Ups

Where conduits are to be stubbed up through concrete floors, a short elbow shall be installed below grade to transition from the horizontal run of conduit to a vertical run. A conduit coupling fitting, threaded on the inside shall be installed, to allow terminating the conduit flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 6 inches above the floor. Empty or spare conduit stub-ups shall be plugged flush with the finished floor with a threaded, recessed plug.

3.2.1.3 Below Slab-on-Grade or in the Ground

Electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing vertically through slabs-on-grade shall be rigid steel or IMC. Rigid steel or IMC conduits installed below slab-on-grade or in the earth shall be field wrapped with 0.010 inch thick pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system.

3.2.1.4 Installing in Slabs Including Slabs on Grade

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NOTE: The number, size, and location of conduits installed in slabs should be coordinated with the structural designer to ensure that the integrity of the slab is not compromised. Slabs with many conduits routed through them will require increased thickness.

****

Conduit installed in slabs-on-grade shall be rigid steel or IMC. Conduits shall be installed as close to the middle of concrete slabs as practicable without disturbing the reinforcement. Outside diameter shall not exceed 1/3 of the slab thickness and conduits shall be spaced not closer than 3 diameters on centers except at cabinet locations where the slab thickness shall be increased as approved by the Contracting Officer. Where conduit is run parallel to reinforcing steel, the conduit shall be spaced a minimum of one conduit diameter away but not less than one inch from the reinforcing steel.

3.2.1.5 Changes in Direction of Runs

Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment shall be prevented during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced.

3.2.1.6 Supports

Metallic conduits and tubing,and the support system to which they are attached, shall be securely and rigidly fastened in place to prevent vertical and horizontal movement at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Cables and raceways shall not be supported by ceiling grids. Except where permitted by NFPA 70, wiring shall not be supported by ceiling support systems. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered. Additional support for horizontal runs is not required when EMT rests on steel stud cutouts.

3.2.1.7   Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations in accordance with NFPA 70 definitions.

3.2.1.8   Exposed Risers

Exposed risers in wire shafts of multistory buildings shall be supported by U-clamp hangers at each floor level, and at intervals not to exceed 10 feet.

3.2.1.9   Exposed Lengths of Conduit, Over 600 Volts

Exposed lengths of conduit containing power conductors operating at more than 600 volts shall have two red bands 2 inches wide spaced 8 inches apart painted near each coupling; the intervening space between the red bands shall be painted white, and on the white space the voltage shall be stenciled in black: [_____] volts.

3.2.1.10   Communications Raceways

****

NOTE: The installation of communications raceways will be coordinated with the local Communications Electronics Officer. Communications raceways will be located where indicated. Delete this paragraph where communications raceways are not required.

****

Communications raceways indicated shall be installed in accordance with the previous requirements for conduit and tubing and with the additional requirement that no length of run shall exceed 50 feet for 1/2 inch and 3/4 inch sizes, and 100 feet for 1 inch or larger sizes, and shall not contain more than two 90-degree bends or the equivalent. Additional pull or junction boxes shall be installed to comply with these limitations whether or not indicated. Inside radii of bends in conduits of 1 inch size or larger shall not be less than ten times the nominal diameter.

3.2.2   Busway Systems

Busway systems shall be of the voltage, capacity, and phase characteristics indicated. Vertical runs of busways within 6 feet of the floor shall have solid enclosures. Busways shall be supported at intervals not exceeding 5 feet, and shall be braced properly to prevent lateral movement. Busways penetrating walls or floors shall be provided with flanges to completely close wall or floor openings.

3.2.3 Cable Trays

Cable trays shall be supported in accordance with the recommendations of the manufacturer but at no more than 6 foot intervals. Contact surfaces of aluminum connections shall be coated with an antioxidant compound prior to assembly. Adjacent cable tray sections shall be bonded together by connector plates of an identical type as the cable tray sections. The Contractor shall submit the manufacturer's certification that the cable tray system meets all requirements of Article 318 of NFPA 70. The cable tray shall be installed and grounded in accordance with the provisions of Article 318 of NFPA 70. Data submitted by the Contractor shall demonstrate that the completed cable tray systems will comply with the specified requirements. Cable trays shall terminate 10 inches from both sides of smoke and fire partitions. Conductors run through smoke and fire partitions shall be installed in 4 inch rigid steel conduits with grounding bushings, extending 12 inches beyond each side of the partitions. The installation shall be sealed to preserve the smoke and fire rating of the partitions. Penetrations shall be firestopped in accordance with Section 07270 FIRESTOPPING.

3.2.4 Cables and Conductors

Installation shall conform to the requirements of NFPA 70. Covered, bare or insulated conductors of circuits rated over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 600 volts or less.

3.2.4.1 Sizing

****

NOTE: Ensure that the temperature rating of the wire insulation type specified does not exceed the temperature ratings of the equipment terminals in the circuit to which the conductor is connected. Higher temperature rated conductors may be used, if the UL listed temperature ratings for the equipment terminals are not exceeded. Conductor sizes for branch circuits and feeders that serve non-linear loads will be based on the use of a minimum 75 degrees C temperature rating.

****

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. Class 3 low-energy, remote-control and signal circuits shall be not less than No. 22 AWG.

3.2.4.2 Use of Aluminum Conductors in Lieu of Copper

****

NOTE: Select the first option if aluminum conductors are not to be used. Otherwise, select the second option.
****

[Aluminum conductors shall not be used.] [Unless otherwise indicated, the Contractor may substitute aluminum conductors in lieu of copper conductors for copper sizes No. 4 AWG and larger. Should the Contractor choose to provide aluminum for conductors, the Contractor shall be responsible for increasing conductor size to have same ampacity as copper size indicated; increasing conduit and pull box sizes to accommodate larger size aluminum conductors in accordance with NFPA 70; ensuring that pulling tension rating of aluminum conductors is sufficient; providing panelboards [and motor control centers] that are UL listed for use with aluminum, and so labelled; relocating equipment, modifying equipment terminations, resizing equipment; and resolving problems that are a direct result of providing aluminum conductors in lieu of copper.]

3.2.4.3 Cable Systems

Cable systems shall be installed where indicated. Cables shall be installed concealed behind ceiling or wall finish where practicable. Cables shall be threaded through holes bored on the approximate centerline of wood members; notching of surfaces will not be permitted. Sleeves shall be provided through bond beams of masonry-block walls for threading cables through hollow spaces. Exposed cables shall be installed parallel or at right angles to walls or structural members. In rooms or areas not provided with ceiling or wall finish, cables and outlets shall be installed so that a room finish may be applied in the future without disturbing the cables or resetting the boxes. Exposed nonmetallic-sheathed cables less than 4 feet above floors shall be protected from mechanical injury by installation in conduit or tubing.

3.2.4.4 Mineral-Insulated Cable

Mineral-insulated, metal-sheathed cable system, Type MI, may be used in lieu of exposed conduit and wiring. Conductor sizes shall be not less than those indicated for the conduit installation. Cables shall be fastened within 12 inches of each turn or offset and at intervals of not more than 6 feet. Cable terminations shall be made in accordance with manufacturer's recommendations.

3.2.4.5 Cable Splicing

Splices shall be made in an accessible location. Crimping tools and dies shall be approved by the connector manufacturer for use with the type of connector and conductor.

a. Copper Conductors, 600 Volt and Under: Splices in conductors No. 10 AWG and smaller diameter shall be made with an insulated, pressure-type connector. Splices in conductors No. 8 AWG and larger diameter shall be made with a solderless connector and insulated with tape or heat-shrink type insulating material equivalent to the conductor insulation.

b. Aluminum Conductors, 600 Volt and Under: Splices of aluminum conductors shall be made with a UL listed, solderless, compression-type, aluminum bodied connector, stamped for AL or AL/CU. Aluminum contact surfaces of conductors shall be cleaned with a wire brush and covered with anti-oxidant joint compound prior to making of connections. Any excess joint compound shall be wiped away after installing the connector. Insulate the connection with tape or heat-shrink type insulating material equivalent to the conductor insulation.

c. Greater Than 600 Volt: Cable splices shall be made in accordance with the cable manufacturer's recommendations and Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

3.2.4.6 Conductor Identification and Tagging

****

NOTE: Where 120/208-volt, 3-phase and 120/240-volt, 1-phase systems are required for the project, colors other than black and red will be used to identify the 120/240-volt system. Specifications will be modified to indicate such a condition.

Where a facility now has a differing standard for power conductor identifications, specifications will be modified to indicate such a condition.

****

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for 3-phase and single-phase low voltage systems shall be as follows:

120/208-volt, 3-phase: Black(A), red(B), and blue(C).
277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).
120/240-volt, 1-phase: Black and red.

b. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 3 inches of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.

c. Control and signal circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

3.3 BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems where required by NFPA 70 for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with screw-fastened covers. Indicated elevations are approximate, except where minimum mounting heights for hazardous areas are required by NFPA 70. Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors. Switch and outlet boxes located on opposite sides of fire rated walls shall be separated by a minimum horizontal distance of 24 inches. The total combined area of all box openings in fire rated walls shall not exceed 100 square inches per 100 square feet. Maximum box areas for individual boxes in fire rated walls vary with the manufacturer and shall not exceed the maximum specified for that box in UL Elec Const Dir. Only boxes listed in UL Elec Const Dir shall be used in fire rated walls.

3.3.1 Box Applications

Each box shall have not less than the volume required by NFPA 70 for number of conductors enclosed in box. Boxes for metallic raceways, 4 by 4 inch nominal size and smaller, shall be of the cast-metal hub type when located in normally wet locations, when flush and surface mounted on outside of exterior surfaces, or when located in hazardous areas. Cast-metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Boxes for mounting lighting fixtures shall be not less than 4 inches square, or octagonal, except smaller boxes may be installed as required by fixture configuration, as approved. Cast-metal boxes with 3/32 inch wall thickness are acceptable. Large size boxes shall be NEMA [1] [2] [3R] [4] [_____] [7] [12] or as shown. Boxes in other locations shall be sheet steel except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic conduit and tubing or nonmetallic sheathed cable system, when permitted by NFPA 70. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers.

3.3.2 Brackets and Fasteners

Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screw or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4 inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel. The use of brackets which depend on gypsum wallboard or plasterboard for primary support will not be permitted. In partitions of light steel construction, bar hangers with 1 inch long studs, mounted between metal wall studs or metal box mounting brackets shall be used to secure boxes to the building structure. When metal box mounting brackets are used, additional box support shall be provided on the side of the box opposite the brackets. This additional box support shall consist of a minimum 12 inch long section of wall stud, bracketed to the opposite side of the box and secured by two screws through the wallboard on each side of the stud. Metal screws may be used in lieu of the metal box mounting brackets.

3.3.3 Mounting in Walls, Ceilings, or Recessed Locations

In walls or ceilings of concrete, tile, or other non-combustible material, boxes shall be installed so that the edge of the box is not recessed more than 1/4 inch from the finished surface. Boxes mounted in combustible walls or ceiling material shall be mounted flush with the finished surface. The use of gypsum or plasterboard as a means of supporting boxes will not be permitted. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry-block walls for concealed wiring shall be mounted flush with the top of a block to minimize cutting of the blocks, and boxes shall be located horizontally to avoid cutting webs of block. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided.

3.3.4 Installation in Overhead Spaces

In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 24 inches from the box.

3.4 DEVICE PLATES

One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel, cast-metal, or impact resistant plastic having rounded or beveled edges. Plates on finished walls shall be of [steel with baked enamel finish or impact-resistant plastic and shall be [ivory] [as indicated]] [satin finish corrosion resistant steel or satin finish chromium plated brass]. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified.

3.5 RECEPTACLES

3.5.1 Single and Duplex, 15 or 20-ampere, 125 volt

****

NOTE: All receptacle locations are to be shown on the drawings including all GFCI receptacles required by NFPA 70 or agency criteria.

****

Single and duplex receptacles shall be rated [15] [20] amperes, 125 volts, two-pole, three-wire, grounding type with polarized parallel slots. Bodies shall be of [ivory] [as indicated] [_____] to match color of switch handles in the same room or to harmonize with the color of the respective wall, and supported by mounting strap having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke. Switched receptacles shall be the same as other receptacles specified except that the ungrounded pole of each suitable receptacle shall be provided with a separate terminal. Only the top receptacle of a duplex receptacle shall be wired for switching application. Receptacles with ground fault circuit interrupters shall have the current rating as indicated, and shall be UL Class A type unless otherwise shown. Ground fault circuit protection shall be provided as required by NFPA 70 and as indicated on the drawings.

3.5.2 Clock Outlet

Clock outlet, for use in other than a wired clock system, shall consist of an outlet box, a plaster cover where required, and a single receptacle with clock-outlet plate. The receptacle shall be recessed sufficiently within the box to allow the complete insertion of a standard cap, flush with the plate. A suitable clip or support for hanging the clock shall be secured to the top of the plate. Material and finish of the plate shall be as specified in paragraph DEVICE PLATES.

3.5.3 Floor Outlets

Floor outlets shall be [adjustable] [nonadjustable] and each outlet shall consist of a cast-metal body with threaded openings for conduits, [adjustable ring] [flange ring], and cover plate with 1/2 inch or 3/4 inch threaded flush plug. Each telephone outlet shall consist of a horizontal cast housing with a receptacle as specified. Gaskets shall be used where necessary to ensure a watertight installation. Plugs with installation instructions shall be delivered to the Contracting Officer at the job site for capping outlets upon removal of service fittings.

3.5.4 Weatherproof Applications

****

NOTE: The requirements for weatherproof receptacles should be clearly identified on the drawings by symbols, notes, and/or defined boundaries. Since the weatherproof designation covers a range of equipment and ratings, the designer must determine the receptacle configuration most suitable for specific areas and identify them in the construction documents. Normally, receptacles or outlet boxes rated for wet locations (subjected to beating rain or run-off) must be rated for wet location use. However, outlet boxes rated for wet location only when cover closed may be used where the active electrical use occurs only during dry or damp intervals and is provided for use with portable equipment or tools only when attended.

Common weatherproof outlet boxes with hinged caps are not configured to keep water out of the assembly

when a plug is inserted and are therefore rated for conditional wet location use (wet location only when cover closed).
****

Weatherproof receptacles shall be suitable for the environment, damp or wet as applicable, and the housings shall be labeled to identify the allowable use. Receptacles shall be marked in accordance with UL 514A for the type of use indicated; "Damp locations", "Wet Locations", "Wet Location Only When Cover Closed". Assemblies shall be installed in accordance with the manufacturer's recommendations.

3.5.4.1 Damp Locations

Receptacles in damp locations shall be mounted in an outlet box with a gasketed, weatherproof, cast-metal cover plate (device plate, box cover) and a gasketed cap (hood, receptacle cover) over each receptacle opening. The cap shall be either a screw-on type permanently attached to the cover plate by a short length of bead chain or shall be a flap type attached to the cover with a spring loaded hinge.

3.5.4.2 Wet Locations

****
NOTE: The last sentence should be included only when the receptacle will be limited for use with a dedicated piece of equipment.
****

Receptacles in wet locations shall be installed in an assembly rated for such use whether the plug is inserted or withdrawn, unless otherwise indicated. In a duplex installation, the receptacle cover shall be configured to shield the connections whether one or both receptacles are in use. [Assemblies which utilize a self-sealing boot or gasket to maintain wet location rating shall be furnished with a compatible plug at each receptacle location and a sign notifying the user that only plugs intended for use with the sealing boot shall be connected during wet conditions].

3.5.5 Receptacles, 15-Ampere, 250-Volt

Receptacles, 15-ampere, 250-volt, shall be [single] [duplex] two-pole, three-wire, grounding type with bodies of [ivory] [as indicated] [_____] phenolic compound supported by mounting yoke having plaster ears. The third grounding pole shall be connected to the metal yoke. Each receptacle shall be provided with a mating cord-grip plug.

3.5.6 Receptacles, 20-Ampere, 250-Volt

Receptacles, single, 20-ampere, 250-volt, shall be [ivory] [as indicated] [_____] molded plastic, two-pole, three-wire or three-pole, four-wire, grounding type complete with appropriate mating cord-grip plug.

3.5.7 Receptacles, 30-Ampere, 125/250-Volt

****
NOTE: All new installations will use three-pole, four-wire, grounding type receptacles with an equipment grounding conductor routed with the supply

conductors. Three-pole, three-wire, non-grounding type receptacles may only be used on existing installations where an equipment grounding conductor, flexible metal strap or wire, or other means permitted by NFPA 70 is provided for the grounding of non-current carrying metal parts.

****

Receptacles, single, 30-ampere, 125/250-volt, shall be molded-plastic, three-pole, [three-wire, non-grounding type] [four-wire, grounding type], complete with appropriate mating cord-grip type attachment plug. Each dryer receptacle shall be furnished with a non-detachable power supply cord for connection to the electric clothes dryer. The cord shall be an angle-type 36 inch length of Type [SRD] [SRDE] [SRDT] range and dryer cable with three No. 10 AWG conductors.

3.5.8   Receptacles, 30-Ampere, 250-Volt

Receptacles, single, 30-ampere, 250-volt, shall be molded-plastic, three-pole, three-wire type, complete with appropriate mating cord-grip plug.

3.5.9   Receptacles, 50-Ampere, 125/250-Volt

****

NOTE: All new installations will use three-pole, four-wire, grounding type receptacles with an equipment grounding conductor routed with the supply conductors. Three-pole, three-wire, non-grounding type receptacles may only be used on existing installations where an equipment grounding conductor, flexible metal strap or wire, or other means permitted by NFPA 70 is provided for the grounding of non-current carrying metal parts.

****

Receptacles, single 50-ampere, 125/250-volt, shall be flush, molded plastic, three-pole, [three-wire, non-grounding] [four-wire, grounding] type. Each range receptacle shall be furnished with a nondetachable power supply cord for connection to the electric range. The cord shall be an angle-type 36 inch length of [SRD] [SRDE] [SRDT] range and dryer cable with one No. 8 and two No. 6 AWG conductors.

3.5.10   Receptacles, 50-Ampere, 250-Volt

Receptacles, single, 50-ampere, 250-volt, shall be flush molded plastic, three-pole, three-wire type, complete with appropriate mating cord-grip plug.

3.5.11   Special-Purpose or Heavy-Duty Receptacles

Special-purpose or heavy-duty receptacles shall be of the type and of ratings and number of poles indicated or required for the anticipated purpose. Contact surfaces may be either round or rectangular. One appropriate straight or angle-type plug shall be furnished with each receptacle. Locking type receptacles, rated 30 amperes or less, shall be locked by rotating the plug. Locking type receptacles, rated more than 50 amperes, shall utilize a locking ring.

3.6 WALL SWITCHES

Wall switches shall be of the totally enclosed tumbler type. The wall switch handle and switch plate color shall be [ivory] [as indicated] [_____]. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than [one switch] [two switches] shall be installed in a single-gang position. Switches shall be rated [15-ampere] [20-ampere] [120] [277]-volt for use on alternating current only. Pilot lights indicated shall consist of yoke-mounted candelabra-base sockets rated at 75 watts, 125 volts, and fitted with glass or plastic jewels. A clear 6-watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be red. Dimming switches shall be solid-state flush mounted, sized for the loads.

3.7 SERVICE EQUIPMENT

****

NOTE: Interrupting capacities of molded-case circuit breaker will be in accordance with UL 489.

****

Service-disconnecting means shall be of the [enclosed molded-case circuit breaker type] [fusible safety switch type] [type indicated] [type indicated in paragraph [PANELBOARDS AND LOADCENTERS] [POWER SWITCHGEAR ASSEMBLIES INCLUDING SWITCHBOARDS]] with an external handle for manual operation. When service disconnecting means is a part of an assembly, the assembly shall be listed as suitable for service entrance equipment. Enclosures shall be sheet metal with hinged cover for surface mounting unless otherwise indicated.

3.8 PANELBOARDS AND LOADCENTERS

****

NOTE: Interrupting capacities of molded-case circuit breakers will be in accordance with UL 489.

****

Circuit breakers and switches used as a motor disconnecting means shall be capable of being locked in the open position. Door locks shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate loads served by each circuit and mounted in a holder behind a clear protective covering. Busses shall be [copper] [aluminum].

3.8.1 Loadcenters

Loadcenters shall be circuit breaker equipped.

3.8.2 Panelboards

Panelboards shall be circuit breaker or fusible switch equipped as indicated on the drawings. [Fusible panelboards of the multipole type may have doors over individual circuits and trim over the wiring gutter only, provided each circuit is arranged for locking in the open and closed positions and each branch circuit has an individual identification card in a cardholder with a clear plastic covering.] [Multipole fusible switches shall be of the hinged-door type; single pole fusible switches shall be of the tumbler switch and fuse type. Switches serving as a motor disconnect means shall be of the tumbler switch and fuse type. Switches serving as motor disconnect means shall be horsepower rated in conformance with UL 98.]

3.9   FUSES

Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilize fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination. Time-delay and non-time-delay options shall be as [shown] [specified].

3.9.1   Cartridge Fuses; Noncurrent-Limiting Type

Cartridge fuses of the noncurrent-limiting type shall be Class H, nonrenewable, dual element, time lag type and shall have interrupting capacity of 10,000 amperes. At 500 percent current, cartridge fuses shall not blow in less than 10 seconds.

3.9.2   Cartridge Fuses; Current-Limiting Type

****

NOTE: Class RK1 provides high current limitation with both time-delay and non-time-delay. RK5 provides moderate current limitation, time-delay option.

****

Cartridge fuses, current-limiting type, Class [G] [J] [K] [L] [RK1] [RK5] [RK9] [T] [CC] shall have tested interrupting capacity not less than [100,000] [200,000] amperes. Fuse holders shall be the type that will reject all Class H fuses.

3.9.3   Continuous Current Ratings (600 Amperes and Smaller)

****

NOTE: Class J or RK1 provide best protection for services and feeders rated 600 amperes or less. Class RK5 may be more cost effective where the greater current limitation of RK1 or J is not a requirement.

****

Service entrance and feeder circuit fuses (600 amperes and smaller) shall be Class [RK1] [RK5] [J], current-limiting, [nontime-delay] [time-delay] with 200,000 amperes interrupting capacity.

3.9.4   Continuous Current Ratings (Greater than 600 Amperes)

Service entrance and feeder circuit fuses (greater than 600 amperes) shall be Class L, current-limiting, [nontime-delay] [time-delay] with 200,000 amperes interrupting capacity.

3.9.5 Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

3.10 UNDERGROUND SERVICE

Unless otherwise indicated, interior conduit systems shall be stubbed out 5 feet beyond the building wall and 2 feet below finished grade, for interface with the exterior service lateral conduits [and exterior communications conduits]. Outside conduit ends shall be bushed when used for direct burial service lateral conductors. Outside conduit ends shall be capped or plugged until connected to exterior conduit systems. Underground service lateral conductors will be extended to building service entrance and terminated in accordance with the requirements of Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and NFPA 70.

3.11 AERIAL SERVICE

Services shall conform to the requirements of Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL, IEEE C2, and NFPA 70. The service drop conductors shall be continuous from the point of connection on the last pole to the service mast or structural support, connected to the service entrance conductors, and shall be routed to a weatherhead, or weatherproof conduit fitting, before entry into an enclosing conduit. A drip loop shall be formed in each service conductor below the entrance to the weatherhead or the weatherproof conduit fitting. The weatherhead or weatherproof service entrance conduit fitting shall be securely fastened to a rigid galvanized steel (RGS) conduit that shall be terminated in the [meter enclosure] [service entrance equipment] which penetrates the [exterior wall] [roof]. [Penetration of the conduit through an exterior wall shall be sealed to prevent the entrance of moisture and the escape of conditioned air.] [A roof penetration fitting shall be provided for the conduit to prevent the entrance of rain.] Service entrance conductors shall be routed in [RGS] [intermediate metal conduit (IMC)] in the exterior wall, or in the interior of the building or facility that contains the [meter enclosure] [service entrance equipment]. Aerial service drop conductors will be extended to building service entrance and terminated.

3.12 MOTORS

Each motor shall conform to the hp and voltage ratings indicated, and shall have a service factor and other characteristics that are essential to the proper application and performance of the motors under conditions shown or specified. Three-phase motors for use on 3-phase 208-volt systems shall have a nameplate rating of 200 volts. Unless otherwise specified, all motors shall have open frames, and continuous-duty classification based on a 40 degree C ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified in other sections of these specifications or shown on contract drawings. The Contractor shall be responsible for selecting the actual horsepower ratings and other motor requirements necessary for the applications indicated. When electrically driven equipment furnished under other sections of these specifications materially differs from the design, the Contractor shall make the necessary adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed.

3.13 MOTOR CONTROL

Each motor or group of motors requiring a single control [and not controlled from a motor-control center] shall be provided under other sections of these specifications with a suitable controller and devices that will perform the functions as specified for the respective motors. Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch shall be provided for the manual control; when the automatic-control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

3.13.1 Reduced-Voltage Controllers

****

NOTE: Reduced voltage controllers will be required when the locked rotor current of a motor exceeds the full-load rating of the supply transformer or supply conductors.

****

Reduced-voltage controllers shall be provided for polyphase motors [_____] [_____] hp or larger. Reduced-voltage starters shall be of the single-step autotransformer, reactor, or resistor type having an adjustable time interval between application of reduced and full voltages to the motors. Wye-delta reduced voltage starters or part winding increment starters having an adjustable time delay between application of voltage to first and second winding of motor may be used in lieu of the reduced voltage starters specified above for starting of motor-generator sets, centrifugally operated equipment or reciprocating compressors provided with automatic unloaders.

3.13.2 Motor Control Centers

Control centers shall be indoor type and shall contain combination starters and other equipment as indicated. Control centers shall be NEMA ICS 2, Class [_____], Type [_____]. Each control center shall be mounted on floor sills or mounting channels. Each circuit shall have a suitable metal or laminated plastic nameplate with white cut letters. Combination starters shall be provided with [circuit breakers.] [fusible switches.] [switches equipped with high-interrupting-capacity current-limiting fuses.] Motor control centers shall be provided with a full-length ground bus bar.

3.13.3 Contacts

Unless otherwise indicated, contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with NEMA ICS 2 for rating designation B300.

3.13.4 Safety Controls

Safety controls for boilers shall be connected to a 2-wire, 120 volt grounded circuit supplied from the associated boiler-equipment circuit. Where the boiler circuit is more than 120 volts to ground, safety controls shall be energized through a two-winding transformer having its 120 volt secondary winding grounded. Overcurrent protection shall be provided in the ungrounded secondary conductor and shall be sized for the load encountered.

3.14 MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by NFPA 70 even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

3.15 TRANSFORMER INSTALLATION

****

NOTE: Liquid-insulated transformers located indoors shall meet all special installation requirements of NFPA 70 for such installations.

****

Three-phase transformers shall be connected only in a delta-wye or wye-delta configuration as indicated [except isolation transformers having a one-to-one turns ratio]. "T" connections may be used for transformers rated at 15 kVA or below. Dry-type transformers shown located within 5 feet of the exterior wall shall be provided in a weatherproof enclosure. Transformers to be located within the [building] [building and vault] may be provided in the manufacturer's standard, ventilated indoor enclosure designed for use in 40 degrees C ambient temperature, unless otherwise indicated.

3.16 LAMPS AND LIGHTING FIXTURES

Ballasted fixtures shall have ballasts which are compatible with the specific type and rating of lamps indicated and shall comply with the applicable provisions of the publications referenced.

3.16.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed in the fixtures just prior to the completion of the project.

3.16.1.1 Incandescent

Incandescent lamps shall be for 125-volt operation unless otherwise indicated.

3.16.1.2 Fluorescent

****

NOTE: Indicate all fluorescent lamp types and colors on the lighting fixture schedule.

****

Fluorescent lamps for magnetic ballasts shall be as indicated and shall be of a type that will not require starter switches. Lamps shall be of the rapid-start type unless otherwise shown or approved. Fluorescent lamps for electronic ballasts shall be as indicated.

3.16.1.3 High-Intensity-Discharge

High-intensity-discharge lamps shall be the high-pressure sodium type unless otherwise indicated, shown, or approved.

3.16.2 Fixtures

****

NOTE: Standard Drawing No. 40-06-04 provides details for the most common types of electric lighting fixtures used in military construction. These detail drawings are prepared to eliminate the necessity for referring to trade names and catalog numbers of proprietary items. For each lighting detail used on a project, include the applicable sheet from Standard Drawing 40-06-04 as part of this guide specification. The corresponding lighting fixture type numbers will be entered on the contract drawings at each fixture outlet or for each area or will be included in a schedule. The same type of fixture should be used for similar lighting applications throughout a project as much as is practicable. It is not intended to restrict the design to exact details and dimensions shown on the drawings.

****

Fixtures shall be as shown and shall conform to the following specifications and shall be as detailed on Standard Drawing No. 40-06-04, Sheet Nos. [_____], which accompany and form a part of this specification for the types indicated. Illustrations shown on these sheets are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent energy efficiency, light distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved. In suspended acoustical ceilings with fluorescent fixtures, the fluorescent emergency light fixtures shall be furnished with self-contained battery packs.

3.16.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation. Open type fluorescent fixtures with exposed lamps shall have a wire-basket type guard.

3.16.2.2 Suspended Fixtures

****

NOTE: Coordinate pendant sway bracing details with the architect. The architect may prefer to provide pendant sway bracing details in locations where appearance is important.

****

Suspended fixtures shall be provided with swivel hangers in order to ensure a plumb installation. Pendants, rods, or chains 4 feet or longer excluding fixture, shall be braced to limit swinging. Bracing shall be 3 directional, 120 degrees apart. Single unit suspended fluorescent fixtures shall have twin-stem hangers. Multiple unit or continuous-row fluorescent units shall have a tubing or stem for wiring at one point, and a tubing or rod suspension provided for each length of chassis including one at each end. Maximum distance between adjacent tubing or stems shall be 10 feet. Rods shall be of not less than 3/16 inch diameter. Flexible raceway shall be installed to each fixture from an overhead junction box. Fixture to fixture wiring installation is allowed only when fixtures are installed end to end in a continuous run.

3.16.2.3 Ceiling Fixtures

Ceiling fixtures shall be coordinated with and suitable for installation in, on, or from the suspended ceiling provided under other sections of these specifications. Installation and support of fixtures shall be in accordance with the NFPA 70 and manufacturer's recommendations. Recessed fixtures shall have adjustable fittings to permit alignment with ceiling panels. Recessed fixtures installed in fire-resistive type of suspended ceiling construction shall have the same fire rating as the ceiling or shall be provided with fireproofing boxes having materials of the same fire rating as the ceiling panels, in conformance with UL Elec Const Dir. Surface-mounted fixtures shall be suitable for fastening to the structural support for ceiling panels.

3.16.2.4 Sockets

Sockets of industrial, strip, and other open type fluorescent fixtures shall be of the type requiring a forced movement along the longitudinal axis of the lamp for insertion and removal of the lamp.

3.16.3 Emergency Light Sets

****

NOTE: The drawings will be checked to ensure that

the number of heads required for each emergency light set has been shown.
****

Emergency light sets shall conform to UL 924 with the number of heads as indicated. Sets shall be permanently connected to the wiring system by conductors installed in short lengths of flexible conduit.

3.17 BATTERY CHARGERS

Battery chargers shall be installed in conformance with NFPA 70.

3.18 EQUIPMENT CONNECTIONS

Wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduits 6 feet or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors. Liquid-tight conduits shall be used in damp or wet locations.

3.18.1 Motors and Motor Control

Motors, motor controls, and motor control centers shall be installed in accordance with NFPA 70, the manufacturer's recommendations, and as indicated. Wiring shall be extended to motors, motor controls, and motor control centers and terminated.

3.18.2 Installation of Government-Furnished Equipment

Wiring shall be extended to the equipment and terminated.

3.18.3 Food Service Equipment Provided Under Other Sections

Wiring shall be extended to the equipment and terminated.

3.19 CIRCUIT PROTECTIVE DEVICES

The Contractor shall calibrate, adjust, set and test each new adjustable circuit protective device to ensure that they will function properly prior to the initial energization of the new power system under actual operating conditions.

3.20 PAINTING AND FINISHING

Field-applied paint on exposed surfaces shall be provided under Section 09900 PAINTING, GENERAL.

3.21 REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Government.

3.22 FIELD TESTING

****

NOTE: Select types to suit project scope, site conditions, or User request and delete all others. Designer will coordinate test requirements with User. Delete all paragraphs not applicable.

****

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer [_____] days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

3.22.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.22.2 Ground-Resistance Tests

The resistance of [each grounding electrode] [each grounding electrode system] [the grounding grid] shall be measured using the fall-of-potential method defined in IEEE Std 81. Soil resistivity in the area of the grid shall be measured concurrently with the grid measurements. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

a. Single rod electrode - [25 ohms] [_____].

b. Grid electrode - [_____] ohms.

3.22.3 Ground-Grid Connection Inspection

All below-grade ground-grid connections will be visually inspected by the Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer [_____] hours before the site is ready for inspection.

3.22.4 Cable Tests

****

NOTE: The insulation resistance test (dielectric test) value is based on the recommendation contained

in IEEE Std 525. The DC high potential test voltage and minimum value shall be based on manufacturer's recommendations.
****

The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all low and medium voltage cables after the cables are installed in their final configuration and prior to energization. The test voltage shall be 500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:

R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

3.22.4.1   Medium Voltage Cable Tests

a. Continuity test.

b. Insulation resistance test.

c. DC high-potential test.

3.22.4.2   Low Voltage Cable Tests

a. Continuity test.

b. Insulation resistance test.

3.22.5   Metal Enclosed Bus Duct Tests

a. Insulation Resistance phase-to-phase, all combinations.

b. Insulation resistance phase-to-ground, each phase.

c. AC or DC high-potential test.

d. Phase rotation test.

3.22.6   Motor Tests

a. Phase rotation test to ensure proper directions.

b. Operation and sequence of reduced voltage starters.

c. High potential test on each winding to ground.

d. Insulation resistance of each winding to ground.

e. Vibration test.

f. Dielectric absorption test on motor [and starter].

3.22.7 Liquid-Filled Transformer Tests

The following field tests shall be performed on all liquid-filled transformers [[_____] kVA and above]

a. Insulation resistance test phase-to-ground, each phase.

b. Turns ratio test.

c. Correct phase sequence.

d. Correct operation of tap changer.

e. [_____]

3.22.8 Dry-Type Transformer Tests

The following field tests shall be performed on all dry-type transformers [[_____] kVA and above].

a. Insulation resistance test phase-to-ground, each phase.

b. Turns ratio test.

c. [_____]

3.22.9 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers.

3.22.9.1 Circuit Breaker Tests, Medium Voltage

a. Insulation resistance test phase-to-phase, all combinations.

b. Insulation resistance tests phase-to-ground, each phase.

c. Closed breaker contact resistance test.

d. Power factor test.

e. High-potential test.

f. Manual and electrical operation of the breaker.

3.22.9.2 Circuit Breakers, Low Voltage

a. Insulation resistance test phase-to-phase, all combinations.

b. Insulation resistance test phase-to-ground, each phase.

c. Closed breaker contact resistance test.

d. Manual and electrical operation of the breaker.

3.22.9.3 Circuit Breakers, Molded Case

a. Insulation resistance test phase-to-phase, all combinations.

b. Insulation resistance test phase-to-ground, each phase.

c. Closed breaker contact resistance test.

d. Manual operation of the breaker.

3.22.10 Motor Control Centers

a. Insulation resistance test phase-to-phase, all combinations.

b. Insulation resistance test phase-to-ground, each phase.

c. Manual and electrical operational tests.

3.22.11 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. These tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to insure proper calibration and operation. Relay settings shall be implemented in accordance with the coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE ANSI/IEEE C57.13.

3.23 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph FIELD TEST REPORTS.

3.24 FIELD SERVICE

3.24.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of [_____] hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A [VHS] [_____] format video tape of the entire training shall be submitted.

3.24.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of equipment, assist in the performance of the onsite tests, oversee initial operations, and instruct personnel as to the operational and maintenance features of the equipment.

3.25 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

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DEPARTMENT OF THE ARMY | **CEGS-16710 (April 1997)**
U.S. ARMY CORPS OF ENGINEERS | **--------------------------**
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SECTION 16710

PREMISES DISTRIBUTION SYSTEM
04/97

****
NOTE: This guide specification covers the requirements for data and telephone signal distribution paths within premises (formerly called inside plant). This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.
Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA ANSI/TIA/EIA-568-A	(1995) Commercial Building Telecommunications Cabling Standard
EIA ANSI/TIA/EIA-569	(1996) Commercial Building Standard for Telecommunications Pathways and Spaces
EIA ANSI/TIA/EIA-606	(1993) Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
EIA ANSI/TIA/EIA-607	(1994) Commercial Building Grounding and Bonding Requirements for Telecommunications
EIA TSB 67	(1995) Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems

IBM PUBLICATION CORPORATION (IBM)

IBM GA27-3361-07	(1987) LAN Cabling System - Planning and Installation
IBM GA27-3773-0	(1987) Cabling System Technical Interface Specifications

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-80-576	(1994) Communications Wire and Cable for Wiring of Premises
ICEA S-83-596	(1994) Fiber Optic Premises Distribution Cable

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996; Errata) National Electrical Code

UNDERWRITERS LABORATORY (UL)

UL 50	(1995; Rev thru Oct 1997) Enclosures for Electrical Equipment

1.2 SYSTEM DESCRIPTION

****

NOTE: Ensure that design provides for adequate communications pathways and spaces using EIA ANSI/TIA/EIA-569 as a minimum requirement. Coordinate electrical, grounding, and HVAC requirements with the associated disciplines. Network type, size and configuration must be coordinated with the user's representative, if known. The same cable pathways and spaces are normally used for both telephone and data (including local area network) systems.

For MCA projects, telephone instruments and other equipment are procured and installed using funds provided by ISEC-CONUS outside of the construction contract. Other types of projects, such as Army Reserve, DOD and work for others, may require that telephone instruments and other specified equipment be added to this section to be procured and installed as part of the construction contract.
****

The premises distribution system shall consist of inside-plant horizontal, riser, and backbone cables and connecting hardware to transport telephone and data (including LAN) signals between equipment items in a building.

1.3 ENVIRONMENTAL REQUIREMENTS

****
NOTE: In new construction or renovation, take into account the heat load of all active electronic equipment to be installed in telecommunications closets and equipment rooms. The designer must estimate these loads and coordinate HVAC requirements. Active electronics must be placed in a conditioned space. Follow requirements of EIA ANSI/TIA/EIA-569 when active electronics are to be located in telecommunications closets and equipment rooms.
****

Connecting hardware shall be rated for operation under ambient conditions of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, noncondensing.

1.4 QUALIFICATIONS

1.4.1 Minimum Contractor Qualifications

All work under this section shall be performed by and all equipment shall be furnished and installed by a certified Telecommunications Contractor, hereafter referred to as the Contractor. With the exception of furnishing and installing conduit, electrical boxes, and pullwires, this work shall not be done by the Electrical Contractor. The Contractor shall have the following qualifications in Telecommunications Systems installation:

a. Contractor shall have a minimum of 3 years experience in the application, installation and testing of the specified systems and equipment.

b. All supervisors and installers assigned to the installation of this system or any of its components shall have factory certification from each equipment manufacturer that they are qualified to install and test the provided products. General electrical trade staff (electricians) shall not be used for the installation of the premises distribution system cables and associated hardware.

c. All installers assigned to the installation of this system or any of its components shall have a minimum of 3 years experience in the installation of the specified copper and fiber optic cable and components.

1.4.2 Minimum Manufacturer Qualifications

The equipment and hardware provided under this contract will be from manufacturers that have a minimum of 3 years experience in producing the types of systems and equipment specified.

1.5 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts; [_____].

Lists of spare parts, tools, and test equipment for each different item of material and equipment specified, after approval of detail drawings, not later than [2] [_____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

SD-04 Drawings

Premises Distribution System; GA.

Detail drawings including a complete list of equipment and material. Detail drawings shall contain complete wiring and schematic diagrams and other details required to demonstrate that the system has been coordinated and will function properly as a system. Drawings shall include vertical riser diagrams, equipment rack details, elevation drawings of telecommunications closet walls, outlet face plate details for all outlet configurations, sizes and types of all cables, conduits, and cable trays. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation.

Record Drawings; GA.

Record drawings for the installed wiring system infrastructure per EIA ANSI/TIA/EIA-606. The drawings shall show the location of all cable terminations and location and routing of all backbone and horizontal cables. The identifier for each termination and cable shall appear on the drawings.

SD-06 Instructions

Manufacturer's Recommendations; GA.

Where installation procedures, or any part thereof, are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations, prior to installation shall be provided. Installation of the item will not be allowed to proceed until the recommendations are received and approved.

SD-08 Statements

Test Plan; GA.

Test plan defining the tests required to ensure that the system meets technical, operational and performance specifications, [60] [_____] days prior to the proposed test date. The test plan must be approved before the start of any testing. The test plan shall identify the capabilities and functions to be tested, and include detailed instructions for the setup and execution of each test and procedures for evaluation and documentation of the results.

Qualifications; GA.

The qualifications of the Manufacturer, Contractor, and the Installer to perform the work specified herein. This shall include proof of the minimum qualifications specified herein.

SD-09 Reports

Test Reports; [_____].

Test reports in booklet form with witness signatures verifying execution of tests. Test results will also be provided on 3-1/2 inch diskettes in [ASCII][_____] format. Reports shall show the field tests performed to verify compliance with the specified performance criteria. Test reports shall include record of the physical parameters verified during testing. Test reports shall be submitted within [7] [14] [_____] days after completion of testing.

SD-13 Certificates

Premises Distribution System; [_____].

Written certification that the premises distribution system complies with the EIA ANSI/TIA/EIA-568-A, EIA ANSI/TIA/EIA-569, and EIA ANSI/TIA/EIA-606 standards.

Materials and Equipment; [_____].

Where materials or equipment are specified to conform, be constructed or tested to meet specific requirements, certification that the items provided conform to such requirements. Certification by a nationally recognized testing laboratory that a representative sample has been tested to meet the requirements, or a published catalog specification statement to the effect that the item meets the referenced standard, will be acceptable as evidence that the item conforms. Compliance with these requirements does not relieve the Contractor from compliance with other requirements of the specifications.

Installers; GA.

The Contractor shall submit certification that all the installers are factory certified to install and test the provided products.

SD-18 Records

Record Keeping and Documentation; GA.

Documentation on cables and termination hardware in accordance with EIA ANSI/TIA/EIA-606.

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust or other contaminants.

1.7 OPERATION AND MAINTENANCE MANUALS

Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance for all products provided as a part of the premises distribution system. Specification sheets for all cable, connectors, and other equipment shall be provided.

1.8 RECORD KEEPING AND DOCUMENTATION

****

NOTE: EIA ANSI/TIA/EIA-606 requires very vigorous record keeping and documentation. Full compliance with EIA ANSI/TIA/EIA-606 will result in significant cost increase and will provide a lot of cable, raceway, and termination hardware documentation which will probably never be used by the customer. In many cases, cable and termination hardware records are not required. Delete these paragraphs if not required.

****

1.8.1 Cables

A record of all installed cable shall be provided [in hard copy format] [on electronic media using DOS based computer cable management software] [on electronic media using Windows based computer cable management software] per EIA ANSI/TIA/EIA-606. [A licensed copy of the cable management software including documentation, shall be provided.] The cable records shall [include only the required data fields] [include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility] per EIA ANSI/TIA/EIA-606.

1.8.2   Termination Hardware

A record of all installed patch panels and outlets shall be provided [in hard copy format] [on electronic media using DOS based computer cable management software] [on electronic media using Windows based computer cable management software] per EIA ANSI/TIA/EIA-606. [A licensed copy of the cable management software including documentation, shall be provided.] The hardware records shall include only the required data fields per EIA ANSI/TIA/EIA-606.

PART 2   PRODUCTS

2.1   MATERIALS AND EQUIPMENT

****

NOTE: For specialized circuits, such as pay phones, coordinate with the local telephone company. Provide electrical and telephone outlets installed per the Americans with Disabilities Act (ADA) to accommodate TTD's and other devices.

Ensure that the NEC 40 percent maximum conduit and other raceways fill is met when sizing raceways.

For projects which require multiple types of cable jackets or special types of cable, indicate the type of each cable on the drawings. For cables which require special jackets, such as those subject to corrosive environments, provide a description of the environmental requirements.

Select the appropriate cable jacket rating (such as CMR, CMG, CMP, OFNG, OFNR or OFNP) based on NEC or local code requirements. If there is a potential for mixed rating of the same cables, use the highest rating only.

When systems furniture is installed as part of the construction contract, insure that systems furniture specifications include EIA ANSI/TIA/EIA-568-A and EIA ANSI/TIA/EIA-569 cabling and raceway standards.

Use fiber optic cable for backbone data service, unless expanding an existing site where other backbone cable types are required or requested by user. Unshielded twisted pair cable is not recommended for backbone cable, but if requested by the user, should meet or exceed the performance of the horizontal distribution (station) cable.

****

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least 1 year prior to installation. Materials and equipment shall conform to the respective publications and other requirements specified below and to the applicable requirements of NFPA 70.

2.2 UNSHIELDED TWISTED PAIR CABLE SYSTEM

****

NOTE: The category for cable, jacks and blocks should be the same throughout each circuit and system. Specify more than one category only if providing more than one system requiring different categories. In general for horizontal cable, Category 3 should be used for voice circuits and Category 5 should be used for data circuits. Verify these criteria with the user.

****

2.2.1 Cable Insulation

For each individual Category 5 cable, the insulation, material used on each pair shall be exactly the same in all physical, electrical, and chemical respects. The use of Teflon insulated, plenum rated Category 5 cable is acceptable for both plenum and non-plenum applications. If Teflon insulated plenum rated cable is used by the Contractor, it shall be Type 4x0, where all four pairs are Teflon insulated. Type 3x1 and 2x2 are not acceptable.

2.2.2 Riser Cable

Riser cable shall meet the requirements of ICEA S-80-576 and EIA ANSI/TIA/EIA-568-A for Category 3 100-ohm unshielded twisted pair cable. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Conductors shall be solid untinned copper [24 AWG] [22 AWG]. Cable shall be rated [CMR] [CMP] per NFPA 70.

2.2.3 Horizontal Cable

Horizontal cable shall meet the requirements of EIA ANSI/TIA/EIA-568-A for Category [3] [5] [3 or 5 (as shown)] horizontal cable. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Conductors shall be solid untinned copper 24 AWG. Cable shall be rated [CMG] [CMP] per NFPA 70.

2.2.4 Connecting Hardware

****

NOTE: Hardware for protecting or connecting hardware and the main distribution frame for termination of outside plant cables entering the facility should be provided by Section 16711 TELEPHONE SYSTEM, OUTSIDE PLANT. If a main distribution frame is required, and not specified for the project in Section 16711, then add a section to cover the wall or floor mounted type unit with sufficient capacity to accommodate both internal and external cable terminations.

****

Connecting and cross-connecting hardware shall be the same category as the cable it serves. Hardware shall be in accordance with and EIA ANSI/TIA/EIA-568-A.

2.2.4.1 Telecommunications Outlets

****

NOTE: Delete outlet plates for system furniture if not required.

Specify single-jack face plates for barracks and unaccompanied personnel housing projects.

If the data distribution cable is other than unshielded twisted pair, provide a single modular jack for the voice outlet and a "data" connector or connectors appropriate for the installed data cable.

Use T568A wiring configuration only unless adding to an existing system where T568B wiring configuration is already in use.

****

Wall and desk outlet plates shall come equipped with [two modular jacks, with the top or left jack labeled "voice" and the bottom or right jack labeled "data"] [one modular jack] [and] [two fiber optic [SC] [ST] type connectors with the top or left connector labeled "A" and the bottom or right connector labeled "B"] [_____]. Modular jacks shall be the same category as the cable they terminate and shall meet the requirements of EIA ANSI/TIA/EIA-568-A. Modular jack pin/pair configuration shall be [T568A] [T568B] per EIA ANSI/TIA/EIA-568-A. Modular jacks shall be [unkeyed] [keyed] [keyed or unkeyed as shown]. Faceplates shall be provided and shall be [ivory] [_____] in color, [stainless steel] [impact resistant plastic] [_____]. Mounting plates shall be provided for system furniture and shall match the system furniture in color. Outlet assemblies used in the premises distribution system shall consist of modular jacks assembled into both simplex and duplex outlet assemblies in single or double gang covers [as specified in this section] [and] [as indicated on the drawings]. The modular jacks shall conform to the requirements of EIA ANSI/TIA/EIA-568-A, Category [3] [5] [3 or 5 (as shown)].

2.2.4.2 Patch Panels

****

NOTE: Recommend patch panels be installed in equipment racks or cabinets which will house future LAN equipment.

****

Patch panels shall consist of eight-position modular jacks, with rear mounted [type 110] [_____] insulation displacement connectors, arranged in rows or columns on [19 inch rack mounted] [23 inch rack mounted] [wall mounted] panels. Jack pin/pair configuration shall be [T568A] [T568B] per EIA ANSI/TIA/EIA-568-A. Jacks shall be [unkeyed] [keyed] [keyed or unkeyed as shown]. Panels shall [be labeled with alphanumeric x-y coordinates] [be provided with labeling space].

2.2.4.3 Patch Cords

****

NOTE: Delete this paragraph if patch cords are not provided. Show length and quantity of patch cords on drawings. Do not exceed allowable link length inclusive of patch cords.

****

Patch cords shall be cable assemblies consisting of flexible, twisted pair stranded wire with eight-position plugs at each end. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Patch cords shall be wired straight through; pin numbers shall be identical at each end and shall be paired to match [T568A] [T568B] patch panel jack wiring per EIA ANSI/TIA/EIA-568-A. Patch cords shall be [unkeyed] [keyed] [keyed or unkeyed as shown]. Patch cords shall be factory assembled.

2.2.4.4 Terminal Blocks

Terminal blocks shall be [wall mounted] [rack mounted] wire termination units consisting of insulation displacement connectors mounted in plastic blocks, frames or housings. Blocks shall be type [110] [66] which meet the requirements of EIA ANSI/TIA/EIA-568-A for category [3] [5] [3 or 5 as shown]. Blocks shall be mounted on standoffs and shall include cable management hardware. Insulation displacement connectors shall terminate 22 or 24 gauge solid copper wire as a minimum, and shall be connected in pairs so that horizontal cable and connected jumper wires are on separate connected terminals.

2.3 SHIELDED TWISTED PAIR CABLE SYSTEM

2.3.1 Backbone Cable

Backbone cable shall meet the requirements of IBM GA27-3773-0 for 150 ohm Shielded Twisted Pair Cable and shall meet or exceed IBM performance requirements for Type 1A cable. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Cable shall be rated [CMP] [CMR] [CMG] per NFPA 70.

2.3.2 Horizontal Cable

Horizontal cable shall meet the requirements of IBM GA27-3773-0 for 150 ohm Shielded Twisted Pair Cable and shall meet or exceed IBM performance requirements for Type 1A cable. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Cable shall be rated [CMG] [CMP] per NFPA 70.

2.3.3 Connecting Hardware

2.3.3.1 Connectors

****

NOTE: Delete requirement for systems furniture mounting plates if not required.

If unshielded twisted pair voice circuits are being installed in this project, delete the outlet faceplate requirement and edit the outlet plate section of the unshielded twisted pair section to include the connectors on that faceplate.
****

Connectors for shielded twisted pair cable shall meet the requirements of EIA ANSI/TIA/EIA-568-A for media interface connectors and IBM GA27-3773-0 for Type 1A data connectors. Connectors shall be of hermaphroditic design and shall be utilized for outlets and patch panel terminations. Outlet faceplates shall be provided and shall be [ivory] [_____] in color, [stainless steel] [impact resistant plastic] [_____], [single gang] [double gang]. Mounting plates shall be provided for systems furniture and shall match the systems furniture in color.

2.3.3.2   Patch Panels

Patch panels shall be [1 9 inch rack mounted][23 inch rack mounted] [wall mounted] panels with openings for shielded twisted pair connectors. Panels shall be [metallic and shall ground the outer shield of the cable] [non-metallic]. Patch panels shall provide strain relief for cables. Panels shall [be labeled with alphanumeric x-y coordinates] [be provided with labeling space].

2.3.3.3   Patch Cords

****
NOTE: Delete this paragraph if patch cords are not provided. Show length and quantity of patch cords on drawings. Do not exceed allowable link length inclusive of patch cords.
****

Patch cords shall be cable assemblies consisting of flexible shielded twisted pair cable with shielded twisted pair type connectors at each end. Cable shall meet the requirements of IBM GA27-3773-0 for 150 ohm Shielded Twisted Pair Cable and shall meet or exceed performance requirements for Type 6A patch panel data cable. Connectors shall meet or exceed the requirements of EIA ANSI/TIA/EIA-568-A for media interface connectors. Patch cords shall be factory assembled.

2.4   COAXIAL CABLE SYSTEM

2.4.1   Backbone Cable

Backbone cable shall meet the requirements of EIA ANSI/TIA/EIA-568-A 10BASE5 for coaxial cable. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Cable shall be rated [CMP] [CMR] [CMG] per NFPA 70. Cable shall have band markings every 8 feetfor transceiver tap placement.

2.4.2   Horizontal Cable

Horizontal cable shall meet the requirements of EIA ANSI/TIA/EIA-568-A 10BASE2 for coaxial cable. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Cable shall be rated [CMP] [CMG] per NFPA 70.

2.4.3 Connecting Hardware

2.4.3.1 Connectors

****

NOTE: Delete requirement for system furniture mounting plates if not required.

If unshielded twisted pair voice circuits are being installed in this project, delete the outlet faceplate requirement and edit the outlet plate section of the unshielded twisted pair section to include the connectors on that faceplate.

****

Connectors shall meet the requirements of EIA ANSI/TIA/EIA-568-A 10BASE5 or 10BASE2 for coaxial cable connectors, as required for the service. [Connectors for riser/backbone cable shall be Type N male.] [Connectors for station cable shall be BNC male.] Station cable faceplates shall be provided and shall be [ivory] [_____] in color, [stainless steel] [impact resistant plastic] [_____], [single gang] [double gang], with double-sided female BNC coupler. Mounting plates shall be provided for system furniture and shall match the furniture system in color.

2.4.3.2 Patch Panels

Patch panels shall be [19 inch rack mounted] [23 inch rack mounted] [wall mounted] panels. Connectors shall be double-sided BNC female, feedthrough type. [Connector mounting surface shall be constructed with a dielectric material.] [Connector mounting surface shall ground the connector shields.] BNC feedthrough connectors shall meet the requirements of EIA ANSI/TIA/EIA-568-A 10BASE2 for coaxial cable connectors. Panels shall [be labeled with alphanumeric x-y coordinates] [be provided with labeling space].

2.4.3.3 Patch Cords

****

NOTE: Delete this paragraph if patch cords are not provided. Show length and quantity of patch cords on drawings.

****

Patch cords shall be cable assemblies consisting of flexible coaxial cable with BNC male connectors at each end. Cable shall meet the requirements of EIA ANSI/TIA/EIA-568-A 10BASE2 for coaxial cable. Connectors shall meet the requirements of EIA ANSI/TIA/EIA-568-A 10BASE2 for coaxial cable connectors.

2.5 FIBER OPTIC CABLE SYSTEM

2.5.1 Backbone Cable

****

NOTE: Use multimode cable for distances of 2 km (6500 feet) or less and singlemode cable for distances greater than 2 km (6500 feet). Use the stated fiber performance characteristics unless site conditions require enhanced operational parameters or band width characteristics. Tight buffered cable is a general purpose cable used for most applications. Refer to industry design guides for further information on cable selection.
****

2.5.1.1 Multimode

Multimode fiber optic backbone cable shall meet the requirements of EIA ANSI/TIA/EIA-568-A and ICEA S-83-596 for 62.5/125 micrometer multimode graded index optical fiber cable. Numerical aperture for each fiber shall be a minimum of 0.275. Cable construction shall be tight buffered type. Individual fibers shall be color coded for identification. Cable shall be imprinted with fiber count and aggregate length at regular intervals. Cable shall be rated [OFNR] [OFNP] [OFNG] per NFPA 70.

2.5.1.2 Singlemode

****
NOTE: Confirm equipment requirements for single mode fiber characteristics; edit as required.
****

Singlemode fiber optic backbone cable shall meet the requirements of ICEA S-83-596 and the following: operation at a center wavelength of [1310] [and] [1550] [_____] nm; core/cladding diameter [8.3 nominal/125] [_____] micrometer; maximum attenuation [2.0 dB/km at 1300 nm, 1.75 dB/km at 1550 nm] [_____]. Numerical aperture for each fiber shall be a minimum of 0.10. Cable construction shall be tight buffered type. Cable shall be imprinted with fiber count and aggregate length at regular intervals. Individual fibers shall be color coded for identification. Cable shall be rated [OFNR] [OFNP] [OFNG] per NFPA 70.

2.5.2 Horizontal Distribution Cable

****
NOTE: Generally, multimode fiber only will be used for horizontal cable. Delete the singlemode paragraph, unless required for this project.

Use stated selections unless site conditions require enhanced attenuation or band width characteristics.
****

2.5.2.1 Multimode

Multimode fiber optic horizontal cable shall meet the requirements of EIA ANSI/TIA/EIA-568-A and ICEA S-83-596 for 62.5/125 micrometer multimode graded index optical fiber cable. Numerical aperture for each fiber shall be a minimum of 0.275. Cable construction shall be tight buffered type, two strands. Individual fibers shall be color coded for identification. Cable shall be imprinted with fiber count, fiber type, and aggregate length at regular intervals of [2][3][_____] feet. Cable shall be rated and marked [OFNP] [OFNG] per NFPA 70.

2.5.2.2 Singlemode

****

NOTE: Confirm equipment requirements for single mode fiber characteristics; edit as required.

****

Singlemode fiber optic horizontal cable shall meet the requirements of ICEA S-83-596 and the following: operation at a center wavelength of [1310] [and] [1550] [_____] nm; core/cladding diameter [8.3 nominal/125] [_____] micrometer; maximum attenuation [2.0 dB/km at 1300 nm, 1.75 dB/km at 1550 nm] [_____]. Numerical aperture for each fiber shall be a minimum of 0.10. Cable construction shall be tight buffered type, two strands. Individual fibers shall be color coded for identification. Cable shall be imprinted with fiber count, fiber type, and aggregate length at regular intervals of [2][3][_____] feet. Cable shall be rated and marked [OFNP] [OFNG] per NFPA 70.

2.5.3 Connecting Hardware

2.5.3.1 Connectors

****

NOTE: Specify SC connectors unless site conditions require ST type.

Delete requirement for system furniture mounting plates if not required.

If unshielded twisted pair voice circuits are being installed in this project, delete the outlet faceplate requirement and edit the outlet plate section of the unshielded twisted pair section to include the connectors on that faceplate.

****

Connectors shall be [SC] [ST] type with ceramic ferrule material with a maximum insertion loss of .5 dB. Connectors shall meet performance requirements of EIA ANSI/TIA/EIA-568-A. Connectors shall be field installable. Connectors shall utilize adhesive for fiber attachment to ferrule. Connectors shall terminate fiber sizes as required for the service. Station cable faceplates shall be provided and shall be [ivory] [_____] in color, [stainless steel] [impact resistant plastic] [_____], [single gang] [double gang], with double-sided female [SC] [ST] coupler. Mounting plates shall be provided for system furniture and shall match the furniture system in color.

2.5.3.2 Patch Panels

****

NOTE: Show cross-connect or interconnect configuration on the drawings.

****

Patch panels shall be a complete system of components by a single manufacturer, and shall provide termination, splice storage, routing, radius limiting, cable fastening, storage, and cross-connection. Patch panels shall be [19 inch rack mounted][23 inch rack mounted] [wall mounted] panels. Patch panels shall provide strain relief for cables. Panels shall [be labeled with alphanumeric x-y coordinates] [be provided with labeling space]. Patch panel connectors and couplers shall be the same type and configuration as used elsewhere in the system.

2.5.3.3 Patch Cords

****

NOTE: Delete this paragraph if patch cords are not provided. Show length and quantity of patch cords on drawings.

****

Patch cords shall be cable assemblies consisting of flexible optical fiber cable with connectors of the same type as used elsewhere in the system. Optical fiber shall be the same type as used elsewhere in the system. Patch cords shall be complete assemblies from manufacturer's standard product lines.

2.6 EQUIPMENT RACKS

2.6.1 Floor Mounted Open Frame

****

NOTE: A minimum of one quad ac outlet will be provided and mounted on the side rail.

****

Floor mounted equipment racks shall be [welded steel] [aluminum] relay racks with uprights to mount equipment [19 inches][23 inches] wide. Uprights shall be 3 inch deep channel, 1-1/4 inches wide, drilled and tapped 12-24 in a 1/2 inch pattern. Racks shall be provided with a standard top crossmember, and predrilled base plate to allow floor fastening. Open frame equipment racks shall be 7 feet in height and [clear coated] [painted] [_____]. AC outlets shall be provided as shown.

2.6.2 Wall Mounted Open Frame

****

NOTE: Delete hinge requirement when not required.

****

Wall mounted open frame equipment racks shall be [steel] [aluminum] relay racks to mount equipment [19 inches][23 inches] wide with standoff brackets for wall mounting. Uprights shall be drilled and tapped 12-24 in a 1/2 inch pattern. Standoff brackets shall be of sufficient length for a [6][_____] inch clearance between rack and wall. Wall mounted open frame racks shall be hinged. AC outlets shall be provided as shown.

2.6.3 Cable Guides

Cable guides shall be specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on [19 inch][23 inch] equipment racks. Cable guides shall consist of ring or bracket-like devices mounted on rack panels for horizontal use or individually mounted for vertical use. Cable guides shall mount to racks by screws and/or nuts and lockwashers.

2.6.4 Floor Mounted Cabinets

Equipment cabinets shall be floor mounted enclosures with side panels, acrylic plastic front doors, rear louvered metal doors, depth-adjustable front and rear mounting rails, and louvered top. Ventilation fans [will be] [will not be] included. Vertical cable management devices shall be integral to the cabinet. Power strips with [12] [6] [_____] outlets shall be provided within the cabinet. Equipment racks shall mount equipment [19 inches][23 inches] wide and shall be 72 inches high and 30 inches deep. Cabinet exteriors shall be painted [blue] [beige] [ivory/off-white] [_____].

2.6.5 Wall Mounted Cabinets

****

NOTE: Provide size on drawings.

****

Wall mounted cabinets shall conform to UL 50 and have boxes constructed of zinc-coated sheet steel with dimensions not less than shown on drawings. Trim shall be fitted with hinged door and flush catch. Doors shall provide maximum openings to the box interiors. Boxes shall be provided with 3/4 inch plywood backboard painted white or a light color. A duplex AC outlet shall be installed within the cabinet.

2.7 EQUIPMENT MOUNTING BACKBOARD

****

NOTE: Specify that at least two walls be covered with backboards per EIA ANSI/TIA/EIA-569 in each telecommunications closet. Show position and size on drawing.

****

Plywood backboards shall be provided, sized as shown, painted with white or light colored paint.

2.8 TELECOMMUNICATIONS OUTLET BOXES

Electrical boxes for telecommunication outlets shall be 4-11/16 inch square by 2-1/8 inches deep with minimum 3/8 inch deep single or two gang plaster ring as shown. Provide a minimum 1 inch conduit.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: Secure and classified areas should meet requirements of NACSIM 5203 and DIAM 50-3 for cable distribution and wiring.

****

System components and appurtenances shall be installed in accordance with NFPA 70, manufacturer's instructions and as shown. Necessary interconnections, services, and adjustments required for a complete and operable signal distribution system shall be provided. Components shall be labeled in accordance with EIA ANSI/TIA/EIA-606. Penetrations in fire-rated construction shall be firestopped in accordance with Section 07840 FIRESTOPPING. Conduits, outlets and raceways shall be installed in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Wiring shall be installed in accordance with EIA ANSI/TIA/EIA-568-A and as specified in Section 16415 ELECTRICAL WORK, INTERIOR. Wiring, and terminal blocks and outlets shall be marked in accordance with EIA ANSI/TIA/EIA-606. Cables shall not be installed in the same cable tray, utility pole compartment, or floor trench compartment with ac power cables. Cables not installed in conduit or wireways shall be properly secured and neat in appearance and, if installed in plenums or other spaces used for environmental air, shall comply with NFPA 70 requirements for this type of installation.

3.1.1 Horizontal Distribution Cable

****

NOTE: Decrease suspension distance for bundled cable. One or two cables can be suspended at 1.5 meters (5 foot) intervals. Delete last two sentences if there are no raised floors.

****

The rated cable pulling tension shall not be exceeded. Cable shall not be stressed such that twisting, stretching or kinking occurs. Cable shall not be spliced. Fiber optic cables shall be installed either in conduit or through type cable trays to prevent microbending losses. Copper cable not in a wireway shall be suspended a minimum of [8][_____] inches above ceilings by cable supports no greater than [60] [_____] inches apart. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 inches shall be maintained when such placement cannot be avoided. Cables shall be terminated; no cable shall contain unterminated elements. Minimum bending radius shall not be exceeded during installation or once installed. Cable ties shall not be excessively tightened such that the transmission characteristics of the cable are altered. In raised floor areas, cable shall be installed after the flooring system has been installed. Cable [6][_____] feet long shall be neatly coiled not less than [12][_____] inches in diameter below each feed point in raised floor areas.

3.1.2 Riser and Backbone Cable

Vertical cable support intervals shall be in accordance with manufacturer's recommendations. Cable bend radius shall not be less than ten times the outside diameter of the cable during installation and once installed. Maximum tensile strength rating of the cable shall not be exceeded. Cable shall not be spliced.

3.1.3 Telecommunications Outlets

3.1.3.1 Faceplates

As a minimum each jack shall be labeled as to its function and a unique number to identify cable link.

3.1.3.2 Cables

Unshielded twisted pair and fiber optic cables shall have a minimum of 6 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturers bend radius for each type of cable shall not be exceeded.

3.1.3.3   Pull Cords

Pull cords shall be installed in all conduit serving telecommunications outlets which do not initially have fiber optic cable installed.

3.1.4   Terminal Blocks

Terminal blocks shall be mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Industry standard wire routing guides shall be utilized.

3.1.5   Unshielded Twisted Pair Patch Panels

****

NOTE: Panel and cable density will determine the port and panel quantity in each rack.

****

Patch panels shall be mounted in equipment racks with sufficient modular jacks to accommodate the installed cable plant plus 10 percent spares. Cable guides shall be provided above, below and between each panel.

3.1.6   Fiber Optic Patch Panels

Patch panels shall be mounted in equipment racks with sufficient ports to accommodate the installed cable plant plus 10 percent spares. A slack loop of fiber shall be provided within each panel. Loop shall be [[3][_____] feet in length.] [provided as recommended by the manufacturer]. The outer jacket of each cable entering a patch panel shall be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

3.1.7   Equipment Racks

Open frame equipment racks shall be bolted to the [floor] [floor slab]. Cable guides shall be bolted or screwed to racks. Racks shall be installed level. Ganged racks shall be bolted together. Ganged rack cabinets shall have adjacent side panels removed. Wall mounted racks shall be secured to the mounting surface to prevent fully loaded racks from separating from the mounting surface.

3.1.8   Rack Mounted Equipment

Equipment to be rack mounted shall be securely fastened to racks by means of the manufacturer's recommended fasteners.

3.2   TERMINATION

Cables and conductors shall sweep into termination areas; cables and conductors shall not bend at right angles. Manufacturer's minimum bending radius shall not be exceeded. When there are multiple system type drops to individual workstations, relative position for each system shall be maintained on each system termination block or patch panel.

3.2.1 Unshielded Twisted Pair Cable

Each pair shall be terminated on appropriate outlets, terminal blocks or patch panels. No cable shall be unterminated or contain unterminated elements. Pairs shall remain twisted together to within the proper distance from the termination as specified in EIA ANSI/TIA/EIA-568-A. Conductors shall not be damaged when removing insulation. Wire insulation shall not be damaged when removing outer jacket.

3.2.2 Shielded Twisted Pair Cable

Each cable shall be terminated on panel-mounted connectors. Cables shall be grounded at patch panels using manufacturer's recommended methods. Shield braid shall be continuous to connector braid terminator. Wire insulation shall not be damaged when removing shield.

3.2.3 Coaxial Cable

Home run type station cables shall be terminated at each end. Backbone cables shall be terminated with appropriate connectors or end-of-line terminators as required. Loop-type cable systems shall be terminated with appropriate drop connectors and terminators as required. Backbone cable shield conductor shall be grounded to communications ground at only one point and shall not make electrical contact with ground anywhere else.

3.2.4 Fiber Optic Cable

Each fiber shall have connectors installed. The pull strength between the connector and the attached fiber shall be not less than [25][_____] pounds. The mated pair loss, without rotational optimization, shall not exceed [1.0] [_____] dB. Fiber optic connectors shall be installed per EIA ANSI/TIA/EIA-568-A.

3.3 GROUNDING

Signal distribution system ground shall be installed in the telecommunications entrance facility and in each telecommunications closet in accordance with EIA ANSI/TIA/EIA-607 and Section 16415 ELECTRICAL WORK, INTERIOR. Equipment racks shall be connected to the electrical safety ground.

3.4 ADDITIONAL MATERIALS

The Contractor shall provide the following additional materials required for facility startup.

a. 10 of each type outlet.

b. 10 of each type cover plate.

c. 1 of each type terminal block for each telecommunications closet.

d. 4 Patch cords of 10 feet for each telecommunications closet.

e. 1 Set of any and all special tools required to establish a cross connect and to change and/or maintain a terminal block.

3.5 ADMINISTRATION AND LABELING

****
NOTE: Coordinate these paragraphs with paragraph RECORD KEEPING AND DOCUMENTATION.
****

3.5.1 Labeling

3.5.1.1 Labels

All labels shall be in accordance with EIA ANSI/TIA/EIA-606.

3.5.1.2 Cable

All cables will be labeled using color labels on both ends with [encoded] [unencoded] identifiers per EIA ANSI/TIA/EIA-606.

3.5.1.3 Termination Hardware

All workstation outlets and patch panel connections will be labeled using color coded labels with [encoded] [unencoded] identifiers per EIA ANSI/TIA/EIA-606.

3.6 TESTING

Materials and documentation to be furnished under this specification are subject to inspections and tests. All components shall be terminated prior to testing. Equipment and systems will not be accepted until the required inspections and tests have been made, demonstrating that the signal distribution system conforms to the specified requirements, and that the required equipment, systems, and documentation have been provided.

3.6.1 Unshielded Twisted Pair Tests

All metallic cable pairs shall be tested for proper identification and continuity. All opens, shorts, crosses, grounds, and reversals shall be corrected. Correct color coding and termination of each pair shall be verified in the communications closet and at the outlet. Horizontal wiring shall be tested from and including the termination device in the communications closet to and including the modular jack in each room. Backbone wiring shall be tested end-to-end, including termination devices, from terminal block to terminal block, in the respective communications closets. These test shall be completed and all errors corrected before any other tests are started.

3.6.2 Category 3 and Category 5 Circuits

[Twenty five percent of the installed category 3 circuits, selected on a random basis,] [and] [All category 5 circuits] shall be tested using a test set that meets the Class II accuracy requirements of EIA TSB 67 standard. Testing shall use the Basic Link Test procedure of EIA TSB 67. If more than 5 percent of the category 3 circuits tested fail, then all category 3 circuits shall be tested. Cables which contain failed circuits shall be replaced and retested to verify the standard is met.

3.6.3 Shielded Twisted Pair

Wiring configuration shall be tested for continuity, opens, shorts, swaps and correct pin configuration; dc resistance both pair-to-pair and wire-to-shield shall be verified. Cable lengths shall be verified. Near end crosstalk shall be tested from 772 kHz to 300 MHz. Ground potential difference between wiring closets, ground potential difference between patch panel and wall outlet, and ground path resistance shall be tested per IBM GA27-3361-07.

3.6.4 Coaxial Cable

Cable shall be tested for continuity, shorts and opens. Characteristic impedance shall be verified over the range of intended operation. Cable length shall be verified. Cable shall be sweep tested for attenuation over the range of intended operation.

3.6.5 Fiber Optic Cable

Unless stated otherwise, tests shall be performed from both ends of each circuit. Connectors shall be visually inspected for scratches, pits or chips and shall be reterminated if any of these conditions exist. Each circuit leg and complete circuit shall be tested for insertion loss at [850 and 1300] [1310 and 1550] [_____] nm using a light source similar to that used for the intended communications equipment. High-resolution optical time domain reflectometer (OTDR) tests shall be performed from one end of each fiber. Scale of the OTDR trace shall be such that the entire circuit appears over a minimum of 80 percent of the X-axis.

-- End of Section --

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DEPARTMENT OF THE ARMY — **CEGS-16721 (May 1999)**
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Superseding
CEGS-16760 (June 1989)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

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05/99

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 16721

INTERCOMMUNICATION SYSTEM
05/99

****

NOTE: This guide specification covers the requirements for electronic intercommunication systems, including master and remote stations of the wired and wireless types. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL: http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

****

PART 1 GENERAL

****

NOTE: This guide specification covers intercommunication systems and lists desirable features of electronic systems; however, not all manufacturers produce products with all the listed features. Manufacturers' catalogs may be consulted as to the features wanted and those features specified. Additional features, requirements, etc., may be made to this specification. Where intercommunication systems are to be used with other communication devices, consideration must be given to the electromagnetic compatibility of the intercommunication system in accordance with AR 5-12. This intercommunication system guide specification does not include all features and

design parameters which are available. However, specifying exact equipment configuration or design parameters which are unnecessarily restrictive to competition should be avoided.
****

1.1 REFERENCES

****
NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 50	(1996; Rev thru Oct 1997) Enclosures for Electrical Equipment

1.2 SYSTEM DESCRIPTION

****
NOTE: This guide specification covers the requirements for three different types of intercommunication systems, one of which shall be selected for the project. The various types are as follows:

Type 1, Direct Connected, Keyed System. This type of system is applicable for relatively small systems (maximum quantity of remote stations approximately 30) and generally when only a small number of master stations (usually 1 or 2) are required. However, if there is a requirement for annunciation at more than one location or a requirement for multiple conversation paths, the use of this system with more than 1 or 2 master stations, or with many more than 30 remote stations may be justified or required.

Type 2, Single Conversation Path, Central Control System. This type of system is applicable to relatively large systems (more than approximately 30 stations) where only one conversation path is required and usually only one master station. This type of system is applicable to BEQ's. This type of system includes public address and paging systems when the unique requirements are included.

Type 3, Multiple Conversation Paths, Central Control System. This type of system is applicable to various size systems where a large portion of the total quantity of stations are master stations. A limited quantity of conversation paths may be specified as required.
****

The system shall be solid state, modular in design, and shall be of the [wired] [and] [wireless] type with [all master stations] [a single master with remote stations] [master and remote stations intermixed] as indicated. [Stations shall have capacity for later expansion to [[_____] master] [and] [[_____] remote] stations [with [_____] handset] without sacrificing any equipment or feature of performance.] [When both wired and wireless circuitry are used, such interface shall not present a reduction of function or quality.]

1.2.1 Sound Reproduction

The intercommunication system shall reproduce a signal at all receiving stations from a 40 dB minimum input signal referenced to a microphone sound pressure level (SPL) over the frequency range of [300] [_____] to [3300] [_____] Hz. The received signal shall have a dynamic range of 30 dB, adjustable at the receiving station. Unless otherwise specified SPL shall be 20 micro Paschal. The root-mean-square (rms) extraneous noise (e.g. hum) level introduced by the intercommunication system shall be at least [30] [_____] dB below the nominal signal level. Distortion, including envelope delay, intermodulation, cross talk, and other nonlinear sources, shall not exceed 5 percent.

1.2.2 System Operation and Service Features

1.2.2.1 Control and Power Requirements

The system shall have a power switch and an associated pilot light for ON and OFF operations. A volume control at each station shall be used to regulate listening volume. System shall operate on 110-125 Vac, single phase, 60 Hz.

1.2.2.2 Call-In Indication

Master stations shall have a "call-in" switch to provide an audible and/or visual indication of incoming calls from remote stations. Individual visual indication shall identify calling station and status, and remain actuated until a call is answered by a master station.

1.2.2.3 Identification Plates

In addition to the manufacturer's standard identification plates, engraved laminated phenolic identification plates shall be provided for each component connection and terminal. Identification labels shall be 3-layer black on white on black, engraved to show white letters on a black background. Any warning or caution labels shall be 3-layered red on white on red, engraved to show white letters on red background. Control switches and knobs shall be clearly marked with their function and status. Identification strips for station selector switches shall be located to clearly identify remote and master stations and shall be protected by transparent plastic inserts.

1.2.2.4   Speaker/Handset Stations

At speaker/handset stations, lifting the handset shall automatically cut out the loudspeaker in the station and all conversation shall be carried through the handset.

1.2.2.5   Privacy Switch

****

NOTE: Where noise does not exceed 55 dB, specify hands-free operation from distances up to 6 m (20 feet). In areas where the noise occasionally exceeds 55 dB, a talk-listen switch which overrides the hands-free operation should be specified. Where a high noise environment exists, delete hands-free operation and specify only a talk-listen switch.

****

A privacy switch shall be provided at each remote station. When in the ON position, the switch shall prevent any transmission of sound from the remote station. When in the OFF position, without further switch manipulation, the station shall respond to incoming calls upon voice activation from anywhere within a 20 foot radius of station.

1.3   SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts; [_____].

After approval of detail drawings and not later than [_____] months prior to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of equipment and component in the system. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-04 Drawings

Intercommunication System; [_____].

Detail drawings shall consist of illustrations, schedules, performance charts, instructions, brochures, diagrams, catalog cuts, manufacturer's data, materials and equipment lists, and operational and general maintenance instructions. Detail drawings shall be submitted for the overall system and for each major component. Drawings shall illustrate how each item of equipment has been coordinated and will function properly in the system. Detail drawings shall include an overall system schematic indicating relationship of intercommunication units on one diagram and showing power source, system controls, impedance matches, plus number, size, and maximum lengths of interconnecting wires and indicate clearances required for maintenance and operation.

SD-09 Reports

Test Plan and Procedures; [_____].

Test plan and procedures for the acceptance test shall explain in detail step-by-step actions and expected results to demonstrate compliance with the requirements specified. The procedures shall also explain methods for simulating the necessary conditions of operation to demonstrate system performance.

Acceptance Tests; [_____].

Upon completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to adjust each component and to prove compliance with the specified performance criteria. Each test report shall include the final position of controls and operating mode of the system. The manufacturer, model number, and serial number of test equipment used in each test shall also be included.

SD-19 Operation and Maintenance Manuals

Intercommunication System; [_____].

[Six] [_____] complete copies of operation manuals outlining the step-by-step procedures required for system start-up, operation and shutdown. The manuals shall include equipment layout and schematics of simplified wiring and control diagrams of the system as installed. Instructions shall include the manufacturer's name, model number, and a brief description of equipment and components, and their basic operating features.

[Six] [_____] complete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides.

1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.5 VERIFICATION OF DIMENSIONS

The Contractor shall become familiar with the details of the work and working conditions, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancies before performing the work.

PART 2 PRODUCTS

2.1 MATERIALS

****
NOTE: Project drawings should clearly indicate the exact location of all stations, conduit, wiring, and junction boxes. State precisely in the project specifications what is to be shown in detail drawings. If no drawings of the locations of master stations, remote stations, junction boxes, etc., are furnished with the specification, the number and type of stations and junction boxes and the distance between them must be included as a part of the project specification.
****

2.1.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that have been in satisfactory use at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Identical Items

Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

2.1.3 Nameplates

Each major component of equipment shall have the manufacturer's name, model number, and serial number on a plate screwed to the equipment.

2.2 TYPE 1 SYSTEM

****
NOTE: Select the appropriate type of system desired (Type 1, 2 or 3) and delete paragraphs pertaining to other systems.
****

Direct connected keyed intercommunication system shall accommodate [_____] stations in any combination of master stations and remote stations. Master and remote stations shall be provided in the quantities indicated. Each master station shall selectively communicate with any other master station and any remote station by actuation of an appropriate selector switch. [Each master station shall be designed to be capable of initiating a message to all other master stations and all remote stations simultaneously or in groups of not less than 10 stations per group.]

2.2.1 Master Station

[Desk] [Surface wall] [Recessed wall] [Rack]-mounted master stations shall as a minimum conform to the following specifications:

Capacity:	Accommodate [_____] stations
Speaker Sensitivity:	Minimum of 40 dB

2.2.2 Intercommunication Amplifier

The system intercommunication amplifier shall as a minimum conform to the following specifications:

Output Power:	2 watts rms or greater
Total Harmonic Distortion:	Less than 5 percent at rated output power with a load equivalent to one station connected to output terminals
Signal-To-Noise Ratio:	60 dB or greater at rated output
Frequency Response:	Plus or minus 2 dB from 200 Hz to 10,000 Hz

2.2.3 Remote Station

[Desk] [Surface wall] [Recessed wall] [Rack]-mounted remote station shall have [stainless steel] [anodized aluminum] faceplate with tamper proof mounting screws and [galvanized steel] [aluminum] backbox [with "station call-in" capabilities]. The remote station shall provide a speaker with a minimum sensitivity of 40 dB for speakers less than 8 inchesin diameter and 45 dB for speakers 8 inches or greater. The remote station shall have a call announcement monitor lamp [and recurring momentary tone].

2.2.4 All-Call Amplifier

All-call amplifier shall as a minimum conform to the following specifications:

Output Power:	Minimum of 0.5 watt rms for each station
Total Harmonic Distortion:	Less than 5 percent at rated output power with a load equivalent to the quantity of stations connected to it in all-call mode of operation
Signal-To-Noise Ratio:	60 dB or greater at rated output
Frequency Response:	Plus or minus 2 dB from 200 Hz to 10,000 Hz

2.3 TYPE 2 SYSTEM

****
NOTE: Coordinate with paragraph TYPE 1 SYSTEM.
****

Single conversation path, central control intercommunication system shall include [an annunciator panel,] a master station, automatic switching equipment, remote stations and all amplifiers, control equipment and ancillary devices required to provide features specified. The master station shall selectively communicate with any remote station by actuating the [two] [three] digit number assigned to that remote station. [The master station shall be designed to communicate with all remote stations simultaneously or in groups of not less than 10 stations by actuating an assigned "all-call" number.] Only the selected remote station shall listen or talk to the master station. A nonselected remote station shall not be able to hear or interfere with any portion of conversation between a master station and the selected remote station. Hanging up the master station handset shall reset the system for next call. The quantity and location of remote stations shall be as indicated on the drawings.

2.3.1 Master Station

[Desk-top] [Rack-mounted] type master station equipped with a handset with a switch for private conversations [with permanently coiled cord, approximately 5 feet long extended] shall be provided. The master station shall have molded shock-resistant plastic [handset and] housing. The housing shall be mounted on a steel base plate with a station selector with ten-digit, silent operating [dial] [touch key] mechanism.

2.3.2 Remote Station

[Desk-top] [Surface wall] [Recessed wall] [Rack-mounted] remote stations with [stainless steel] [anodized aluminum] face plates with tamperproof mounting screws and [galvanized steel] [aluminum] backbox shall be provided. [A call-in switch mounted on a faceplate to provide selective call-in to master station shall be provided as an integral part of the remote station.] The remote stations shall provide a speaker with a minimum sensitivity of 40 dB for speakers less than 8 inchesin diameter and at least 45 dB for speakers 8 inches or greater. The remote shall have a call announcement monitor lamp [and recurring momentary tone].

2.3.3 Amplifier

2.3.3.1 Intercommunication Amplifier

Intercommunication amplifiers shall as a minimum conform to the following specifications:

Output Power:	2 watts rms or greater
Total Harmonic Distortion:	Less than 5 percent at rated output power with a load equivalent to one station connected to output terminals
Signal-to-Noise Ratio:	60 dB or greater at rated output

Frequency Response:	Plus or minus 2 dB from 200 Hz to 10,000 Hz

2.3.3.2   All-Call Amplifier

All-call amplifiers shall as a minimum conform to the following specifications:

Output Power:	Minimum of 0.5 watt rms for each station
Total Harmonic Distortion:	Less than 5 percent at rated output power with a load equivalent to quantity of stations connected to it in all-call mode of operation
Signal-to-Noise Ratio:	60 dB or greater at rated output
Frequency Response:	Plus or minus 2 dB from 50 Hz to 10,000 Hz

2.3.4   Horn-Type Loudspeakers

Horn-type loudspeakers shall be provided with line transformers and mounting brackets and shall as a minimum conform to the following specifications:

Frequency Response:	Plus or minus 3 dB from 250 Hz to 10,000 Hz
Power Rating:	25 [_____] watts
Horizontal Dispersion Angle:	[57] [90] [115] [_____]
Vertical Dispersion Angle:	[57] [90] [115] [_____]
Axial Sensitivity:	Minimum of [60] [_____] dB
Line Transformers Power Rating:	At least 4 watts

2.4   TYPE 3 SYSTEM

****
NOTE: Coordinate with paragraph TYPE 1 SYSTEM.
****

A multiple conversation path central control intercommunication system shall be provided. The system shall be capable of communicating with other master stations and remote stations selectively or in any combination thereof. Each master station shall selectively communicate with any other master station or any remote station by actuating number assigned to called station. [Each master station shall also be designed to initiate a message to all other master stations and all remote stations simultaneously or in groups of not less than 10 stations.] Station quantities shall be as indicated on drawings.

2.4.1   Master Station

[Desk-top] [Surface wall] [Recessed wall] [Rack-mounted] master stations with ten-digit [dial] [touch key] station selector mechanism. The master station shall have a speaker-microphone with at least 40 dB sensitivity. The master station shall also have a push-button type reset button to cancel calls and reset system for next call.

2.4.2 Remote Station

[Desk-top] [Surface wall] [Recessed wall] [Rack-mounted] remote stations with [stainless steel] [anodized aluminum] face plates with tamperproof mounting screws and [galvanized steel] [aluminum] backbox shall be provided. [A call-in switch mounted on a faceplate to provide selective call-in to master station shall be provided as an integral part of the remote station.] The remote stations shall provide speakers with a minimum sensitivity of 40 dB for speakers less than 8 inches in diameter and at least 45 dB for speakers 8 inches or greater.

2.4.3 Control Cabinet

Central control cabinet shall be of the size to house intercommunication amplifiers, system volume control, and other switching and control devices required to provide conversation channels, while also providing the required air circulation.

2.4.4 Amplifier

2.4.4.1 Intercommunication Amplifier

Intercommunication amplifiers shall as a minimum conform to the following specifications:

Output Power:	Minimum of 2 watts rms
Total Harmonic Distortion:	Less than 5 percent at rated output power with a load equivalent to one station connected to output terminals
Signal-to-Noise Ratio:	60 dB or greater at rated output
Frequency Response:	Plus or minus 2 dB from 50 Hz to 10,000 Hz

2.4.4.2 All-Call Amplifier

All-call amplifiers shall as a minimum conform to the following specifications:

Output Power:	Minimum of 0.5 watts rms per station
Total Harmonic Distortion:	Less than 5 percent at rated output power with a load equivalent to [_____] stations connected to output terminal
Signal-to-Noise Ratio:	60 dB or greater at rated output

Frequency Response:	Plus or minus 2 dB from 50 Hz to 10,000 Hz

2.4.5 Horn-Type Loudspeakers

Horn-type loudspeakers shall be provided complete with line transformer and mounting brackets and shall as a minimum conform to the following specifications:

Frequency Response:	Plus or minus 3 dB from 250 Hz to 10,000 Hz
Power Rating:	25 [_____] watts
Horizontal Dispersion Angle:	[57] [90] [115] [_____] degrees
Vertical Dispersion Angle:	[57] [90] [115] [_____] degrees
Axial Sensitivity:	[57] [60] dB
Line Transformers Power Rating:	At least 4 watts

2.5 SPEAKER ENCLOSURES

Speaker enclosures shall be compatible with the speakers specified and comply with UL 50.

2.6 TERMINALS

Terminals shall be [solderless, tool-crimped pressure] [or] [_____] type.

2.7 COMMUNICATIONS WIRING

Type of signal and control circuit wire and number of conductors shall be provided as recommended by the intercommunication system manufacturer, and as necessary to provide a complete and operable system. Where required, cable shall be UL classified low smoke and low flame for use in air plenums in accordance with NFPA 70.

2.8 SURGE PROTECTION

Major components of the system such as Master Stations, Amplifiers, and Remote Stations, shall have a device, either internal or external, which shall provide protection against voltage spikes and current surges.

PART 3 EXECUTION

3.1 INSTALLATION

All system components and appurtenances shall be installed in accordance with the manufacturer's instructions and as specified and shown. Units to be mounted outside or subject to inclement conditions shall be weatherproof or be mounted in weatherproof enclosures.

3.1.1 Signal and Control Circuits Wiring

Signal and control circuits shall be installed in accordance with NFPA 70 and as indicated.

3.1.2 Conduit, Cable Tray and Tubing Systems

Wiring shall be installed in rigid conduit, intermediate metal conduits, cable trays, or electric metallic tubing as specified in Section 16415 ELECTRICAL WORK, INTERIOR.

3.2 GROUNDING

The connection of interfacing components shall be accomplished through the use of transformers and the tying of interconnecting lines to a unit ground bus at one end only. The ground and distribution ground buses shall be solid copper wire with insulating covering.

3.3 ACCEPTANCE TESTS

After installation has been completed, the Contractor shall conduct an acceptance test, using the approved test plan, to demonstrate that the equipment operates in accordance with specification requirements. The Contractor shall notify the Contracting Officer [_____] days prior to the performance of tests. In no case shall notice be given until after the Contractor has received written approval of the test plans. The acceptance tests shall include originating and receiving messages at specified stations, at proper volume levels, without cross-talk or noise from other links or nondesignated units.

3.4 TRAINING

The Contractor shall conduct a training course for [_____] members of the operating and maintenance staff as designated by the Contracting Officer. The training course will be given at the installation during normal working hours for a total of [_____] hours and shall start after the system is functionally complete but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operating and maintenance instructions, as well as the demonstration of routine maintenance operations. The Contracting Officer shall be notified at least 14 days prior to the start of the training course.

-- End of Section --

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DEPARTMENT OF THE ARMY **HED-01430 (February 1998)**
U.S. ARMY CORPS OF ENGINEERS **----------------------**
Superseding
HED-01430 (October 1997)

GUIDE SPECIFICATION FOR MILITARY CONSTRUCTION

****

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****

SECTION 01430

ENVIRONMENTAL PROTECTION
02/98

****
NOTE: This guide specification covers the requirements for environmental protection. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-720.
****

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

STATE OF HAWAII DEPARTMENT OF HEALTH (HIDOH)

HIDOH, Chapter 43	Administrative Rules, Title 11, Community Noise Control for Oahu
HIDOH, Chapter 59	Administrative Rules, Ambient Air Quality Standards
HIDOH, Chapter 60	Administrative Rules, Air Pollution Control

1.2 GENERAL REQUIREMENTS

This section covers prevention of environmental pollution and damage as the result of construction operations under this contract and for those measures set forth in the TECHNICAL REQUIREMENTS. For the purpose of this specification, environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of air, water, and land, and includes management of visual aesthetics, noise, solid waste, radiant energy and radioactive materials, as well as other pollutants.

1.2.1 Subcontractors

Assurance of compliance with this section by subcontractors will be the responsibility of the Contractor.

1.2.2 Notification

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with the aforementioned Federal[,] [State] or local laws or regulations, permits, and other elements of the Contractor's environmental protection plan. The Contractor shall, after receipt of such notice, inform the Contracting Officer of proposed corrective action and take such action as may be approved. If the Contractor fails to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions will be granted or costs or damages allowed to the Contractor for any such suspension.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the projects should be one of the primary factors in determining if a submittal for the item should required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

****

Government approval is required for submittals with "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-18 Records

Environmental Protection Plan; GA.

Within 30 calendar days of receipt of Notice to Proceed, the Contractor shall submit in writing an environmental protection plan. Approval of the Contractor's plan will not relieve the Contractor of his responsibility for adequate and continuing control of pollutants and other environmental protection measures. The environmental protection plan shall include but not be limited to the following:

a. A list of Federal[,] [State,] and local laws, regulations, and permits concerning environmental protection, pollution control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits.

****

NOTE: This paragraph will be edited based on editing of text herein.

****

b. Methods for protection of features to be preserved within authorized work areas. The Contractor shall prepare a listing of methods to protect resources needing protection; i.e., trees, shrubs, vines, grasses and ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, archeological, and cultural resources.

c. Procedures to be implemented to provide the required environmental protection and to comply with the applicable laws and regulations. The Contractor shall set out the procedures to be followed to correct pollution of the environment due to accident, natural causes, or failure to follow the procedures set out in accordance with the environmental protection plan.

d. Location of the solid waste disposal area.

e. Drawings showing locations of any proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials.

f. Environmental monitoring plans for the job site, including land, water, air, and noise monitoring.

g. Traffic control plan.

h. Methods of protecting surface and ground water during construction activities.

i. Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas.

j. Plan of borrow area(s).

k. Training for his personnel during the construction period.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 PROTECTION OF ENVIRONMENTAL RESOURCES

The environmental resources within the project boundaries and those affected outside the limits of permanent work under this contract shall be protected during the entire period of this contract. The Contractor shall confine his activities to areas defined by the drawings and specifications.

3.1.1 Land Resources

Prior to the beginning of any construction, the Contractor shall identify all land resources to be preserved within the Contractor's work area. Except in areas indicated on the drawings or specified to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without special permission from the Contracting Officer. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. Where such special emergency use is permitted, the Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs.

3.1.1.1 Work Area Limits

Prior to any construction, the Contractor shall mark the areas that are not required to accomplish all work to be performed under this contract. Isolated areas within the general work area which are to be saved and protected shall also be marked or fenced. Monuments and markers shall be protected before construction operations commence. Where construction operations are to be conducted during darkness, the markers shall be visible. The Contractor shall convey to his personnel the purpose of marking and/or protection of all necessary objects.

3.1.1.2 Protection of Landscape

Trees, shrubs, vines, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved shall be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques.

3.1.1.3 Reduction of Exposure of Unprotected Erodible Soils

Earthwork brought to final grade shall be finished as indicated and specified. Side slopes and back slopes shall be protected as soon as practicable upon completion of rough grading. All earthwork shall be planned and conducted to minimize the duration of exposure of unprotected soils. Except in instances where the constructed feature obscures borrow areas, quarries, and waste material areas, these areas shall not initially be cleared in total. Clearing of such areas shall progress in reasonably sized increments as needed to use the areas developed as approved by the Contracting Officer.

3.1.1.4 Protection of Disturbed Areas

Such methods as necessary shall be utilized to effectively prevent erosion and control sedimentation, including but not limited to the following:

a. Retardation and Control of Runoff: Runoff from the construction site shall be controlled by construction of diversion ditches, benches, and berms to retard and divert runoff to protected drainage courses, and any measures required by areawide plans approved under Paragraph 208 of the Clean Water Act.

b. Erosion and Sedimentation Control Devices: The Contractor shall construct or install all temporary and permanent erosion and sedimentation control features as indicated on the drawings. Temporary erosion and sediment control measures such as berms, dikes, drains, [sedimentation basins,] grassing, and mulching shall be maintained until permanent drainage and erosion control facilities are completed and operative.

[c. Sediment Basins: Sediment from construction areas shall be trapped in temporary or permanent sediment basins in accordance with basin plans shown on the drawings. The basins shall accommodate the runoff of a local [design year] storm. After each storm, the basins shall be pumped dry and accumulated sediment shall be removed as necessary to maintain basin effectiveness. Overflow shall be controlled by paved weir or by vertical overflow pipe, draining from the surface. The collected topsoil sediment shall be reused for fill on the construction site, and/or conserved (stockpiled) for use at another site(s). The Contractor shall institute effluent quality monitoring programs as required by [State and] local environmental agencies.]

3.1.1.5 Contractor Facilities and Work Areas

a. Location of Field Offices, Storage, and Other Contractor Facilities: The Contractors' field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas designated on the drawings or as directed by the Contracting Officer. Temporary movement or relocation of Contractor facilities shall be made only on approval by the Contracting Officer.

b. Borrow Areas on Government Property: Borrow areas shall be managed to minimize erosion and to prevent sediment from entering nearby waters.

c. Spoil Areas on Government Property: Spoil areas shall be managed and controlled to limit spoil to areas designated on the drawings and prevent erosion of soil or sediment from entering nearby waters. Spoil areas shall be developed in accordance with the grading plan indicated on the drawings.

d. Temporary Excavations and Embankments: Temporary excavations and embankments for plant and/or work areas shall be controlled to protect adjacent areas from despoilment.

3.1.2 Disposal of Wastes

Disposal of wastes shall be as specified in [Section 01900 MISCELLANEOUS PROVISIONS] [Section 02050 DEMOLITION] and as specified hereinafter.

3.1.2.1 Solid Wastes

Solid wastes (excluding clearing debris) shall be placed in containers which are emptied on a regular schedule. All handling and disposal shall be conducted to prevent contamination. Segregation measures shall be employed such that no hazardous or toxic waste will become commingled with solid waste. [The Contractor shall transport all solid waste off Government property and dispose of it in compliance with Federal, State, and local requirements for solid waste disposal.] [Waste materials shall be hauled to the Government landfill site [shown on the drawings.] [designated by the Contracting Officer.] The Contractor shall comply with [site procedures and with] Federal[,] [State,] and local laws and regulations pertaining to the use of landfill areas.]

3.1.2.2 Chemical Wastes:

****

NOTE: For Kwajalein projects, the first bracketed paragraph will be deleted and the second bracketed paragraph will be retained.

For all other projects the first bracketed paragraph will be retained.

****

[Chemical wastes shall be stored in corrosion resistant containers, removed from the work area and disposed of in accordance with Federal[,] [State,] and local laws and regulations.]

[Chemicals shall be dispensed in a way to adequately ensure no spillage to ground or water. Periodic inspections of dispensing areas to identify leakage and initiate corrective action shall be performed and documented. This documentation will be periodically reviewed by the Government. Chemical waste shall be collected in corrosion resistant containers with care taken to ensure compatibility. Collection drums shall be monitored and removed to a staging or storage area when contents are within six inches of the top. All waste shall be disposed of in accordance with Federal and local laws and regulations.]

3.1.2.3   Hazardous Wastes:

The Contractor shall take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing and shall collect waste in suitable containers observing compatibility. The Contractor shall transport all hazardous waste off Government property and dispose of it in compliance with Federal and local laws and regulations. Spills of hazardous or toxic materials shall be immediately reported to the Contracting Officer. Cleanup and cleanup costs due to spills shall be the responsibility of the Contractor.

3.1.3   Historical, Archeological, and Cultural Resources

[Existing historical, archeological, and cultural resources within the Contractor's work area will be so designated by the Contracting Officer if any has been identified. The Contractor shall take precautions to preserve all such resources as they existed at the time they were pointed out to him. The Contractor shall provide and install all protection for these resources so designated and shall be responsible for their preservation during this contract.] If during excavation or other construction activities [in areas with existing or known resources, as well as in any other work area], any [previously] unidentified or unanticipated resources are discovered or found, all activities that may damage or alter such resources shall be temporarily suspended. These resources or cultural remains (prehistoric or historic surface or subsurface) include but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rocks or coral alignments, paving, wall, or other constructed features; and any indication of agricultural or other uses. Upon such discovery or find, the Contractor shall immediately notify the Contracting Officer. When so notified, the Contracting Officer will initiate action so that prompt and proper data recovery can be accomplished. In the mean time, recording and preservation of historical and archeological finds during construction activities shall be reported in accordance with the SPECIAL CONTRACT REQUIREMENTS.

3.1.4   Water Resources

****

NOTE: For Kwajalein projects, the last bracketed sentence will be retained.

****

The Contractor shall keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters. Special management techniques as set out below shall be implemented to control water pollution by the listed construction activities which are included in this contract. [In particular, toxic or hazardous chemicals shall not be applied to soil or vegetation in a manner that may cause contamination of the fresh water reserve.]

3.1.4.1 Washing and Curing Water

****

NOTE: For Kwajalein projects, the last bracketed sentence will be retained.

****

Waste waters directly derived from [Insert Name(s) of Process Producing the Wastewater] construction activities shall not be allowed to enter water areas. These waste waters shall be collected and placed in retention ponds where suspended material can be settled out or the water evaporates so that pollutants are separated from the water. [Analysis shall be performed and results reviewed and approved by the Government before water in retention ponds is discharged.]

3.1.4.2 Cofferdam and Diversion Operations

The Contractor shall plan his operation and perform all work necessary to minimize adverse impact of violation of the water quality standard for [Insert Name of Water Area(s)]. Construction operations for dewatering, removal of cofferdams, tailrace excavation, and tunnel closure shall be controlled at all times to limit the impact of water turbidity on the habitat for wildlife and impacts on water quality for downstream use.

3.1.4.3 Stream Crossings

Stream crossings shall be controlled during construction. Crossings shall provide movement of materials or equipment which do not violate water pollution control standards of the Federal[,] [State] or local government.

3.1.4.4 Monitoring of Water Areas:

Monitoring of water areas affected by construction activities shall be the responsibility of the Contractor. All water areas affected by construction activities shall be monitored by the Contractor.

3.1.5 Fish and Wildlife Resources

The Contractor shall keep construction activities under surveillance, management and control to minimize interference with, disturbance to and damage of fish and wildlife. Species that require specific attention along with measures for their protection will be listed by the Contractor prior to beginning of construction operations.

3.1.6 Air Resources

The Contractor shall keep construction activities under surveillance, management and control to minimize pollution of air resources. All activities, equipment, processes, and work operated or performed by the Contractor in accomplishing the specified construction shall be in strict accordance with [HIDOH, Chapter 59, HIDOH, Chapter 60, and] all Federal emission and performance laws and standards. Ambient Air Quality Standards set by the Environmental Protection Agency shall be maintained for those construction operations and activities specified in this section. Special management techniques as set out below shall be implemented to control air pollution by the construction activities which are included in the contract.

3.1.6.1 Particulates

a. Dust particles, aerosols, and gaseous by-products from all construction activities, processing and preparation of materials, such as from asphaltic batch plants, shall be controlled at all times, including weekends, holidays and hours when work is not in progress.

b. The Contractor shall maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause the air pollution standards mentioned in paragraph Air Resources, herein before, to be exceeded or which would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated at such intervals as to keep the disturbed area damp at all times. The Contractor must have sufficient competent equipment available to accomplish this task. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs.

3.1.6.2 Hydrocarbons and Carbon Monoxide

Hydrocarbons and carbon monoxide emissions from equipment shall be controlled to Federal [and State] allowable limits at all times.

3.1.6.3 Odors

Odors shall be controlled at all times for all construction activities, processing and preparation of materials.

3.1.6.4 Monitoring of Air Quality

****

NOTE: For Kwajalein projects, the last bracketed sentence will be retained.

****

Monitoring of air quality shall be the responsibility of the Contractor. All air areas affected by the construction activities shall be monitored by the Contractor. [Monitoring results will be periodically reviewed by the Government to ensure compliance.]

3.1.7 Sound Intrusions

The Contractor shall keep construction activities under surveillance, and control to minimize damage to the environment by noise. [The Contractor shall comply with the provisions of HIDOH, Chapter 43.]

3.2 POST CONSTRUCTION CLEANUP

The Contractor shall clean up area(s) used for construction.

3.3 RESTORATION OF LANDSCAPE DAMAGE

The Contractor shall restore all landscape features damaged or destroyed during construction operations outside the limits of the approved work areas. Such restoration shall be in accordance with the plan submitted for approval by the Contracting Officer. This work will be accomplished at the Contractor's expense.

3.4 MAINTENANCE OF POLLUTION CONTROL FACILITIES

The Contractor shall maintain all constructed facilities and portable pollution control devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

3.5 TRAINING OF CONTRACTOR PERSONNEL IN POLLUTION CONTROL

The Contractor shall train his personnel in all phases of environmental protection. The training shall include methods of detecting and avoiding pollution, familiarization with pollution standards, both statutory and contractual, and installation and care of facilities (vegetative covers, and instruments required for monitoring purposes) to ensure adequate and continuous environmental pollution control.

-- End of Section --

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DEPARTMENT OF THE ARMY **HED-01451 (January 2000)**
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GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 1 (October 1997)

Latest Notice change indicated by CHG tags

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS

HED-01451 (January 2000)

Superseding
HED-01451 (March 1997)

GUIDE SPECIFICATION FOR CONSTRUCTION

Includes changes through Notice 1 (October 1997)

Latest Notice change indicated by CHG tags

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SECTION 01451

CONTRACTOR QUALITY CONTROL
01/00

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NOTE: This guide specification covers requirements for Contractor Quality Control. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-700.

Comments and suggestions on thisguide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3740	(1996) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM E 329	(1995b) Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

1.2 PAYMENT

Separate payment will not be made for providing and maintaining an effective Quality Control program, and all costs associated therewith shall be included in the applicable unit prices or lump-sum prices contained in the Bidding Schedule.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL

The Contractor is responsible for quality control and shall establish and maintain an effective quality control system in compliance with the Contract Clause titled "Inspection of Construction." The quality control system shall consist of plans, procedures, and organization necessary to produce an end product which complies with the contract requirements. The system shall cover all construction operations, both onsite and offsite, and shall be keyed to the proposed construction sequence. The project superintendent will be held responsible for the quality of work on the job and is subject to removal by the Contracting Officer for non-compliance with quality requirements specified in the contract. The project superintendent in this context shall mean the individual with the responsibility for the overall management of the project including quality and production.

3.2 QUALITY CONTROL PLAN

3.2.1 General

The Contractor shall furnish for review by the Government, not later than 30 days after receipt of notice to proceed, the Contractor Quality Control (CQC) Plan proposed to implement the requirements of the Contract Clause titled "Inspection of Construction." The plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used. The Government will consider an interim plan for the first 90 days of operation. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of work to be started. Work outside of the features of work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of work to be started.

3.2.2 Content of the CQC Plan

The CQC Plan shall include, as a minimum, the following to cover all construction operations, both onsite and offsite, including work by subcontractors, fabricators, suppliers, and purchasing agents:

a. A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff shall implement the three phase control system for all aspects of the work specified. The staff shall include a CQC System Manager who shall report to the project superintendent.

b. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function. Technicians responsible for sampling and testing of concrete shall be certified by the American Concrete Institute (ACI) or the Concrete Technicians Association of Hawaii (CTAH). Proof of certification shall be included in the CQC Plan. Personnel qualifications may be furnished incrementally as the work progresses, but in no case, less than fourteen (14) calendar days before personnel are required on the job.

c. A copy of the letter to the CQC System Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop work which is not in compliance with the contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Copies of these letters shall also be furnished to the Government.

d. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with Section 01330 SUBMITTAL PROCEDURES.

e. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test.

f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.

g. Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures shall establish verification that identified deficiencies have been corrected.

h. Reporting procedures, including proposed reporting formats.

i. A list of the definable features of work. A definable feature of work is a task which is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable features under a particular section. This list will be agreed upon during the coordination meeting.

3.2.3 Acceptance of Plan

Acceptance of the Contractor's plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Government reserves the right to require the Contractor to make changes in his CQC Plan and operations including removal of personnel, as necessary, to obtain the quality specified.

3.2.4 Notification of Changes

After acceptance of the CQC Plan, the Contractor shall notify the Contracting Officer in writing of any proposed change. Proposed changes are subject to acceptance by the Contracting Officer.

3.3 COORDINATION MEETING

After the Preconstruction Conference, before start of construction, and prior to acceptance by the Government of the CQC Plan, the Contractor shall meet with the Contracting Officer or Authorized Representative and discuss the Contractor's quality control system. The CQC Plan shall be submitted for review a minimum of 7 calendar days prior to the Coordination Meeting. During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting shall be prepared by the Government and signed by both the Contractor and the Contracting Officer. The minutes shall become a part of the contract file. There may be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures which may require corrective action by the Contractor.

3.4 QUALITY CONTROL ORGANIZATION

3.4.1 General

The requirements for the CQC organization are a CQC System Manager and sufficient number of additional qualified personnel to ensure contract compliance. The Contractor shall provide a CQC organization which shall be at the site at all times during progress of the work and with complete authority to take any action necessary to ensure compliance with the contract. All CQC staff members shall be subject to acceptance by the Contracting Officer.

3.4.2 CQC System Manager

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NOTE: The designer should insert desired requirements, evaluate the project to determine the level of CQC System Manager required, and select options accordingly.

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NOTE: The CEGS directs that the designer insert

desired requirements based on project knowledge. Except for major construction projects (hospitals, hotels, etc.) requiring project specific preparation for necessarily stricter CQC System Manager's requirement, one of the two following two paragraphs shall be selected by the designer, which will be reviewed by field office during BCOE review for validation or changing of option selection as preferred.
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NOTE: Larger projects greater than $1 millon, choose 1st bracket. Smaller projects less than $1 million, choose 2nd bracket.
****

[The Contractor shall identify as CQC System Manager an individual within the onsite work organization who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the Contractor. The CQC System Manager shall be a construction person with a minimum of 5 years in related work. This CQC System manager shall be on the site at all time during construction and shall be employed by the prime Contractor. The CQC System Manger shall be assigned no other duties. An alternate for the CQC System Manager shall be identified in the plan to serve in the event of the System Manager's absence. The requirements for the alternate shall be the same as the designated CQC System Manager.]

[The Contractor shall identify as CQC System Manager an individual within the onsite work organization who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the Contractor. The CQC System Manager shall be a construction person with a minimum of 5 years in related work. This CQC System Manager shall be on the site at all times during construction and shall be employed by the prime Contractor. The CQC System Manager shall be assigned as System Manager, but may have duties as project superintendent in addition to quality control. An alternate for the CQC System Manager shall be identified in the plan to serve in the event of the System Manager's absence. The requirement for the alternate shall be the same as for the designated CQC Systems Manager.]

3.4.3 CQC Personnel

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NOTE: Insert desired requirements if the complexity, or size of the project warrants specialized individuals in specific disciplines to perform quality control. Select options accordingly.
****

In addition to CQC personnel specified elsewhere in the contract, the Contractor shall provide as part of the CQC organization specialized personnel to assist the CQC System Manager. If it is subsequently determined by the Contracting Officer that the minimum contract CQC requirements are not being met, the Contractor may be required to provide additional staff personnel to the CQC organization at no cost to the Government.

3.4.4 Additional Requirement

The CQC System Manager shall have completed the course entitled "Construction Quality Management For Contractors". This course is periodically offered at the General Contractors Association of Hawaii. There is no charge for the course; however, the Contractor will pay travel and per diem costs. If the CQC manager has not attended the course, he/she will have 90 days from the Notice to Proceed to take it. This is a three-day course, four hours per day. In lieu of this course, the CQC manager may submit a Certificate of Completion from attending the same entitled course offered by any other Corps of Engineers District office.

3.4.5 Organizational Changes

The Contractor shall maintain the CQC staff at full strength at all times. When it is necessary to make changes to the CQC staff, the Contractor shall revise the CQC Plan to reflect the changes and submit the changes to the Contracting Officer for acceptance.

3.5 SUBMITTALS

Submittals shall be made as specified in Section 01330 SUBMITTAL PROCEDURES. The CQC organization shall be responsible for certifying that all submittals are in compliance with the contract requirements.

3.6 CONTROL

Contractor Quality Control is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. At least three phases of control shall be conducted by the CQC System Manager for each definable feature of work as follows:

3.6.1 Preparatory Phase

This phase shall be performed prior to beginning work on each definable feature of work, after all required plans/documents/materials are approved/accepted, and after copies are at the work site. This phase shall include:

a. A review of each paragraph of applicable specifications.

b. A review of the contract drawings.

c. A check to assure that all materials and/or equipment have been tested, submitted, and approved.

d. Review of provisions that have been made to provide required control inspection and testing.

e. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the contract.

f. A physical examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.

g. A review of the appropriate activity hazard analysis to assure safety requirements are met.

h. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of work.

i. A check to ensure that the portion of the plan for the work to be performed has been accepted by the Contracting Officer.

j. Discussion of the initial control phase.

****

NOTE: Notification for preparatory phase shall be as follows:

Oahu - 48 hours
Kwajalein - 72 hours
Outer Island - 7 days
Pacific Areas - Construction to provide during BCOE process review

****

k. The Government shall be notified at least [_____] [hours] [days] in advance of beginning the preparatory control phase. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The results of the preparatory phase actions shall be documented by separate minutes prepared by the CQC System Manager and attached to the daily CQC report. The Contractor shall instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

3.6.2 Initial Phase

This phase shall be accomplished at the beginning of a definable feature of work. The following shall be accomplished:

a. A check of work to ensure that it is in full compliance with contract requirements. Review minutes of the preparatory meeting.

b. Verify adequacy of controls to ensure full contract compliance. Verify required control inspection and testing.

c. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with required sample panels as appropriate.

d. Resolve all differences.

e. Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.

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NOTE: Notificaton for initial phase shall be as

follows:

Oahu - 24 hours
Kwajalein - 72 - hours
OuterIsland - 7 days
****

f. The Government shall be notified at least [_____] [hours] [days] in advance of beginning the initial phase. Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the daily CQC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.

g. The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.

3.6.3 Follow-up Phase

Daily checks shall be performed to assure control activities, including control testing, are providing continued compliance with contract requirements, until completion of the particular feature of work. The checks shall be made a matter of record in the CQC documentation. Final follow-up checks shall be conducted and all deficiencies corrected prior to the start of additional features of work which may be affected by the deficient work. The Contractor shall not build upon nor conceal non-conforming work.

3.6.4 Additional Preparatory and Initial Phases

Additional preparatory and initial phases shall be conducted on the same definable features of work if the quality of on-going work is unacceptable, if there are changes in the applicable CQC staff, onsite production supervision or work crew, if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.7 TESTS

3.7.1 Testing Procedure

The Contractor shall perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements. Upon request, the Contractor shall furnish to the Government duplicate samples of test specimens for possible testing by the Government. Testing includes operation and/or acceptance tests when specified. The Contractor shall obtain the services of an industry recognized testing laboratory, or may establish a testing laboratory at the project site acceptable to the Contracting Officer. However, tests contractually required to be performed by an industry recognized testing laboratory shall not be accomplished by the Contractor established on-site laboratory. The Contractor shall perform the following activities and record and provide the following data:

a. Verify that testing procedures comply with contract requirements.

b. Verify that facilities and testing equipment are available and comply with testing standards.

c. Check test instrument calibration data against certified standards.

d. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.

e. Results of all tests taken, both passing and failing tests, shall be recorded on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test shall be given. If approved by the Contracting Officer, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an offsite or commercial test facility shall be provided directly to the Contracting Officer. Failure to submit timely test reports as stated may result in nonpayment for related work performed and disapproval of the test facility for this contract.

3.7.2 Testing Laboratories

3.7.2.1 Laboratory Accreditation

The testing laboratory performing the actual testing on the project shall be accredited by one of the following laboratory accreditation authorities:

American Association of State Highway and Transportation Officials
National Voluntary Laboratory Accreditation Program
American Association for Laboratory Accreditation
Washington Association of Building Officials

The testing laboratory shall submit an acknowledgement letter from one of the listed laboratory accreditation authorities indicating that the application for accreditation has been received and the accreditation process started.

3.7.2.2 Capability Check

The Government reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt, and steel shall meet criteria detailed in ASTM D 3740 and ASTM E 329.

3.7.2.3 Capability Recheck

If the selected laboratory fails the capability check, the Contractor shall reimburse reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the contract amount due the Contractor.

3.7.3 Onsite Laboratory

The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

3.7.4 Furnishing or Transportation of Samples for Testing

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NOTE: Insert appropriate addresses.
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Costs incidental to the transportation of samples or materials shall be borne by the Contractor. Samples of materials for test verification and acceptance testing by the Government shall be delivered to a testing laboratory on the Island of Oahu, State of Hawaii, designated by the Contracting Officer. Coordination for each specific test, exact delivery location, and dates will be made through the Government field office.

3.8 COMPLETION INSPECTION

3.8.1 Punch-Out Inspection

Near the completion of all work or any increment thereof established by a completion time stated in the Special Clause entitled "Commencement, Prosecution, and Completion of Work," or stated elsewhere in the specifications, the CQC System Manager shall conduct an inspection of the work and develop a punch list of items which do not conform to the approved drawings and specifications. Such a list of deficiencies shall be included in the CQC documentation, as required by paragraph DOCUMENTATION below, and shall include the estimated date by which the deficiencies will be corrected. The CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected. Once this is accomplished, the Contractor shall notify the Government that the facility is ready for the Government Pre-Final inspection.

3.8.2 Pre-Final Inspection

The Government will perform this inspection to verify that the facility is complete and ready to be occupied. The QC Manager shall develop a punch list of items which do not conform to the contract documents. The Government will review the punch list and add to or correct the items listed. The QC Manager shall incorporate Government comments and provide a Pre-Final Punch List. The Contractor's CQC System Manager shall ensure that all items on this list have been corrected before notifying the Government so that a Final inspection with the customer can be scheduled. Any items noted on the Pre-Final inspection shall be corrected in a timely manner. These inspections and any deficiency corrections required by this paragraph shall be accomplished within the time slated for completion of the entire work or any particular increment thereof if the project is divided into increments by separate completion dates.

3.8.3 Final Acceptance Inspection

The Contractor's Quality Control Inspection personnel, plus the superintendent or other primary management person, and the Contracting Officer's Representative shall be in attendance at this inspection. Additional Government personnel including, but not limited to, those from Base/Post Civil Facility Engineer user groups, and major commands may also be in attendance. The final acceptance inspection will be formally scheduled by the Contracting Officer based upon results of the Pre-Final inspection. Notice shall be given to the Contracting Officer at least 14 days prior to the final acceptance inspection and shall include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final acceptance inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with the contract clause titled "Inspection of Construction".

3.9 DOCUMENTATION

The Contractor shall maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the work of subcontractors and suppliers and shall be on an acceptable form that includes, as a minimum, the following information:

a. Contractor/subcontractor and their area of responsibility.

b. Operating plant/equipment with hours worked, idle, or down for repair.

c. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.

d. Test and/or control activities performed with results and references to specifications/drawings requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.

e. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications/drawings requirements.

f. Submittals reviewed, with contract reference, by whom, and action taken.

g. Off-site surveillance activities, including actions taken.

h. Job safety evaluations stating what was checked, results, and instructions or corrective actions.

i. Instructions given/received and conflicts in plans and/or specifications.

j. Contractor's verification statement.

These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. The original and one copy of these records in report form shall be furnished to the Government daily within 24 hours after the date covered by the report, except that reports need not be submitted for days on which no work is performed. As a minimum, one report shall be prepared and submitted for every 7 days of no work and on the last day of a no work period. All calendar days shall be accounted for throughout the life of the contract. The first report following a day of no work shall be for that day only. Reports shall be signed and dated by the CQC System Manager. The report from the CQC System Manager shall include copies of test reports and copies of reports prepared by all subordinate quality control personnel.

3.10 NOTIFICATION OF NONCOMPLIANCE

The Contracting Officer will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

-- End of Section --

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DEPARTMENT OF THE ARMY **CEGS-01500 (February 1997)**
U.S. ARMY CORPS OF ENGINEERS
Superseding
CEGS-01500 (September 1993)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 01500

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02/97

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DEPARTMENT OF THE ARMY **CEGS-01500 (February 1997)**
U.S. ARMY CORPS OF ENGINEERS **---------------------------**
Superseding
CEGS-01500 (September 1993)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 01500

TEMPORARY CONSTRUCTION FACILITIES
02/97

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NOTE: This guide specification covers the requirements for temporary construction facilities. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-1-8155.

Comments and suggestions on this guide specification are welcome and should be directed to the proponent of the specification. A listing of proponents, including their organization designation and telephone number, is at URL http://www.hnd.usace.army.mil/techinfo/index.htm, and an electronic feedback page for submission of recommended changes is available at the same address. Use of electronic communication is encouraged.
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1.1 GENERAL REQUIREMENTS

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NOTE: This guide specification includes requirements which may be included in projects when applicable. Requirements will be added, deleted, or modified as necessary to meet project requirements.
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1.1.1 Site Plan

The Contractor shall prepare a site plan indicating the proposed location and dimensions of any area to be fenced and used by the Contractor, the number of trailers to be used, avenues of ingress/egress to the fenced area and details of the fence installation. Any areas which may have to be graveled to prevent the tracking of mud shall also be identified. The Contractor shall also indicate if the use of a supplemental or other staging area is desired.

1.1.2 Identification of Employees

The Contractor shall be responsible for furnishing to each employee, and for requiring each employee engaged on the work to display, identification as approved and directed by the Contracting Officer. Prescribed identification shall immediately be delivered to the Contracting Officer for cancellation upon release of any employee. When required, the Contractor shall obtain and provide fingerprints of persons employed on the project. Contractor and subcontractor personnel shall wear identifying markings on hard hats clearly identifying the company for whom the employee works.

1.1.3 Employee Parking

Contractor employees shall park privately owned vehicles in an area designated by the Contracting Officer. This area will be within reasonable walking distance of the construction site. Contractor employee parking shall not interfere with existing and established parking requirements of the military installation.

1.2 AVAILABILITY AND USE OF UTILITY SERVICES

1.2.1 Payment for Utility Services

The Government will make all reasonably required utilities available to the Contractor from existing outlets and supplies, as specified in the contract. Unless otherwise provided in the contract, the amount of each utility service consumed shall be charged to or paid for by the Contractor at prevailing rates charged to the Government or, where the utility is produced by the Government, at reasonable rates determined by the Contracting Officer. The Contractor shall carefully conserve any utilities furnished without charge.

1.2.2 Meters and Temporary Connections

The Contractor, at its expense and in a manner satisfactory to the Contracting Officer, shall provide and maintain necessary temporary connections, distribution lines, and meter bases (Government will provide meters) required to measure the amount of each utility used for the purpose of determining charges. The Contractor shall notify the Contracting Officer, in writing, 5 working days before final electrical connection is desired so that a utilities contract can be established. The Government will provide a meter and make the final hot connection after inspection and approval of the Contractor's temporary wiring installation. The Contractor shall not make the final electrical connection.

1.2.3 Advance Deposit

An advance deposit for utilities consisting of an estimated month's usage or a minimum of $50.00 will be required. The last monthly bills for the fiscal year will normally be offset by the deposit and adjustments will be billed or returned as appropriate. Services to be rendered for the next fiscal year, beginning 1 October, will require a new deposit. Notification of the due date for this deposit will be mailed to the Contractor prior to the end of the current fiscal year.

1.2.4 Final Meter Reading

Before completion of the work and final acceptance of the work by the Government, the Contractor shall notify the Contracting Officer, in writing, 5 working days before termination is desired. The Government will take a final meter reading, disconnect service, and remove the meters. The Contractor shall then remove all the temporary distribution lines, meter bases, and associated paraphernalia. The Contractor shall pay all outstanding utility bills before final acceptance of the work by the Government.

1.2.5 Sanitation

The Contractor shall provide and maintain within the construction area minimum field-type sanitary facilities approved by the Contracting Officer. Government toilet facilities will not be available to Contractor's personnel.

1.2.6 Telephone

The Contractor shall make arrangements and pay all costs for telephone facilities desired.

1.3 BULLETIN BOARD, PROJECT SIGN, AND PROJECT SAFETY SIGN

1.3.1 Bulletin Board

Immediately upon beginning of work, the Contractor shall provide a weatherproof glass-covered bulletin board not less than 36 by 48 inches in size for displaying the Equal Employment Opportunity poster, a copy of the wage decision contained in the contract, Wage Rate Information poster, and other information approved by the Contracting Officer. The bulletin board shall be located at the project site in a conspicuous place easily accessible to all employees, as approved by the Contracting Officer. Legible copies of the aforementioned data shall be displayed until work is completed. Upon completion of work the bulletin board shall be removed by and remain the property of the Contractor.

1.3.2 Project and Safety Signs

The requirements for the signs, their content, and location shall be as shown on the drawings. The signs shall be erected within 15 days after receipt of the notice to proceed. The data required by the safety sign shall be corrected daily, with light colored metallic or non-metallic numerals. Upon completion of the project, the signs shall be removed from the site.

1.4 PROTECTION AND MAINTENANCE OF TRAFFIC

During construction the Contractor shall provide access and temporary relocated roads as necessary to maintain traffic. The Contractor shall maintain and protect traffic on all affected roads during the construction period except as otherwise specifically directed by the Contracting Officer. Measures for the protection and diversion of traffic, including the provision of watchmen and flagmen, erection of barricades, placing of lights around and in front of equipment and the work, and the erection and maintenance of adequate warning, danger, and direction signs, shall be as required by the State and local authorities having jurisdiction. The traveling public shall be protected from damage to person and property. The Contractor's traffic on roads selected for hauling material to and from the site shall interfere as little as possible with public traffic. The Contractor shall investigate the adequacy of existing roads and the allowable load limit on these roads. The Contractor shall be responsible for the repair of any damage to roads caused by construction operations.

1.4.1 Haul Roads

The Contractor shall, at its own expense, construct access and haul roads necessary for proper prosecution of the work under this contract. Haul roads shall be constructed with suitable grades and widths; sharp curves, blind corners, and dangerous cross traffic shall be avoided. The Contractor shall provide necessary lighting, signs, barricades, and distinctive markings for the safe movement of traffic. The method of dust control, although optional, shall be adequate to ensure safe operation at all times. Location, grade, width, and alignment of construction and hauling roads shall be subject to approval by the Contracting Officer. Lighting shall be adequate to assure full and clear visibility for full width of haul road and work areas during any night work operations. Upon completion of the work, haul roads designated by the Contracting Officer shall be removed.

1.4.2 Barricades

The Contractor shall erect and maintain temporary barricades to limit public access to hazardous areas. Such barricades shall be required whenever safe public access to paved areas such as roads, parking areas or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic. Barricades shall be securely placed, clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night.

1.5 CONTRACTOR'S TEMPORARY FACILITIES

1.5.1 Administrative Field Offices

The Contractor shall provide and maintain administrative field office facilities within the construction area at the designated site. Government office and warehouse facilities will not be available to the Contractor's personnel.

1.5.2 Storage Area

The Contractor shall construct a temporary 6 foot high chain link fence around trailers and materials. The fence shall include plastic strip inserts, colored [green] [brown], so that visibility through the fence is obstructed. Fence posts may be driven, in lieu of concrete bases, where soil conditions permit. Trailers, materials, or equipment shall not be placed or stored outside the fenced area unless such trailers, materials, or equipment are assigned a separate and distinct storage area by the Contracting Officer away from the vicinity of the construction site but within the military boundaries. Trailers, equipment, or materials shall not be open to public view with the exception of those items which are in support of ongoing work on any given day. Materials shall not be stockpiled outside the fence in preparation for the next day's work. Mobile equipment, such as tractors, wheeled lifting equipment, cranes, trucks, and like equipment, shall be parked within the fenced area at the end of each work day.

1.5.3 Supplemental Storage Area

Upon Contractor's request, the Contracting Officer will designate another or supplemental area for the Contractor's use and storage of trailers, equipment, and materials. This area may not be in close proximity of the construction site but shall be within the military boundaries. Fencing of materials or equipment will not be required at this site; however, the Contractor shall be responsible for cleanliness and orderliness of the area used and for the security of any material or equipment stored in this area. Utilities will not be provided to this area by the Government.

1.5.4 Appearance of Trailers

Trailers utilized by the Contractor for administrative or material storage purposes shall present a clean and neat exterior appearance and shall be in a state of good repair. Trailers which, in the opinion of the Contracting Officer, require exterior painting or maintenance will not be allowed on the military property.

1.5.5 Maintenance of Storage Area

Fencing shall be kept in a state of good repair and proper alignment. Should the Contractor elect to traverse, with construction equipment or other vehicles, grassed or unpaved areas which are not established roadways, such areas shall be covered with a layer of gravel as necessary to prevent rutting and the tracking of mud onto paved or established roadways; gravel gradation shall be at the Contractor's discretion. Grass located within the boundaries of the construction site shall be mowed for the duration of the project. Grass and vegetation along fences, buildings, under trailers, and in areas not accessible to mowers shall be edged or trimmed neatly.

1.5.6 New Building

In the event a new building is constructed for the temporary project field office, it shall be a minimum 12 feet in width, 16 feet in length and have a minimum of 7 feet headroom. It shall be equipped with approved electrical wiring, at least one double convenience outlet and the required switches and fuses to provide 110-120 volt power. It shall be provided with a work table with stool, desk with chair, two additional chairs, and one legal size file cabinet that can be locked. The building shall be waterproof, shall be supplied with heater, shall have a minimum of two doors, electric lights, a telephone, a battery operated smoke detector alarm, a sufficient number of adjustable windows for adequate light and ventilation, and a supply of approved drinking water. Approved sanitary facilities shall be furnished. The windows and doors shall be screened and the doors provided with dead bolt type locking devices or a padlock and heavy duty hasp bolted to the door. Door hinge pins shall be non-removable. The windows shall be arranged to open and to be securely fastened from the inside. Glass panels in windows shall be protected by bars or heavy mesh screens to prevent easy access to the building through these panels. In warm weather, air conditioning capable of maintaining the office at 50 percent relative humidity and a room temperature 20 degrees F below the outside temperature when the outside temperature is 95 degrees F, shall be furnished. Any new building erected for a temporary field office shall be maintained by the Contractor during the life of the contract and upon completion and acceptance of the work shall become the property of the Contractor and shall be removed from the site. All charges for telephone service for the temporary field office shall be borne by the Contractor, including long distance charges up to a maximum of $75.00 per month.

1.5.7 Security Provisions

Adequate outside security lighting shall be provided at the Contractor's temporary facilities. The Contractor shall be responsible for the security of its own equipment; in addition, the Contractor shall notify the appropriate law enforcement agency requesting periodic security checks of the temporary project field office.

1.6 GOVERNMENT FIELD OFFICE

1.6.1 Resident Engineer's Office

The Contractor shall provide the Government Resident Engineer with an office, approximately 200 square feet in floor area, located where directed and providing space heat, electric light and power, and toilet facilities consisting of one lavatory and one water closet complete with connections to water and sewer mains. A mail slot in the door or a lockable mail box mounted on the surface of the door shall be provided. At completion of the project, the office shall remain the property of the Contractor and shall be removed from the site. Utilities shall be connected and disconnected in accordance with local codes and to the satisfaction of the Contracting Officer.

1.6.2 Trailer-Type Mobile Office

The Contractor may, at its option, furnish and maintain a trailer-type mobile office acceptable to the Contracting Officer and providing as a minimum the facilities specified above. The trailer shall be securely anchored to the ground at all four corners to guard against movement during high winds.

1.7 PLANT COMMUNICATION

Whenever the Contractor has the individual elements of its plant so located that operation by normal voice between these elements is not satisfactory, the Contractor shall install a satisfactory means of communication, such as telephone or other suitable devices. The devices shall be made available for use by Government personnel.

1.8 TEMPORARY PROJECT SAFETY FENCING

As soon as practicable, but not later than 15 days after the date established for commencement of work, the Contractor shall furnish and erect temporary project safety fencing at the work site. The safety fencing shall be a high visibility orange colored, high density polyethylene grid or approved equal, a minimum of 42 inches high, supported and tightly secured to steel posts located on maximum 10 foot centers, constructed at the approved location. The safety fencing shall be maintained by the Contractor during the life of the contract and, upon completion and acceptance of the work, shall become the property of the Contractor and shall be removed from the work site.

1.9 CLEANUP

Construction debris, waste materials, packaging material and the like shall be removed from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways shall be cleaned away. Materials resulting from demolition activities which are salvageable shall be stored within the fenced area described above or at the supplemental storage area. Stored material not in trailers, whether new or salvaged, shall be neatly stacked when stored.

1.10 RESTORATION OF STORAGE AREA

Upon completion of the project and after removal of trailers, materials, and equipment from within the fenced area, the fence shall be removed and will become the property of the Contractor. Areas used by the Contractor for the storage of equipment or material, or other use, shall be restored to the original or better condition. Gravel used to traverse grassed areas shall be removed and the area restored to its original condition, including top soil and seeding as necessary.

-- End of Section --

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DEPARTMENT OF THE ARMY **HED-01900 (September 1999)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**

Supercedes (February 1998)

GUIDE SPECIFICATION FOR MILITARY CONSTRUCTION

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DEPARTMENT OF THE ARMY **HED-01900 (September 1999)**
U.S. ARMY CORPS OF ENGINEERS **------------------------**

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GUIDE SPECIFICATION FOR MILITARY CONSTRUCTION
****

SECTION 01900

MISCELLANEOUS PROVISIONS
09/99

****
NOTE: This guide specification covers the requirements for miscellaneous provisions. This guide specification is to be used in the preparation of project specifications in accordance with ER 110-345-720.
****

PART 1 GENERAL

This section is provided for general guidance only. Special provisions for each individual task order will be provided as required. This section shall be included and modified, if required, for work plans prepared under each task order in this contract.

1.1 SUBMITTALS

****
NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
****

Government approval is required for submittals with a "GA" designation; submittals having a "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment Data; FIO.
****
NOTE: Include this submittal for all Kwajalein projects. Delete this submittal for all other projects unless otherwise directed by the POD Technical Manager.

****

A list of all equipment furnished under this contract. This list shall include, but not be limited to, each piece of equipment with a serial number, and shall include all information shown on the manufacturer's nameplate, so as to positively identify the piece of equipment. This list shall also include the cost of each piece of equipment (less installation costs) F.O.B. construction site. This list shall be furnished as soon as possible after equipment is purchased. The list shall consist of one (1) reproducible and three (3) copies, and shall be furnished to the Contracting Officer not later than thirty (30) calendar days prior to completion of any segment of the contract work which has an incremental completion date.

SD-04 Drawings

As-Built Drawings; FIO.

SD-07 Schedules

Progress Chart; GA. Bar Chart; GA.

****

NOTE: SD-07 Schedules and SD-09 Reports were developed for and will be retained for family housing projects.

****

The Contractor shall prepare and submit for approval by the Contracting Officer a progress chart in accordance with the CONTRACT CLAUSE entitled "SCHEDULE FOR CONSTRUCTION CONTRACTS" twenty-one (21) calendar days prior to initiation of any work. Any material change to the progress chart must be approved in writing in advance by the Contracting Officer. [In addition to and along with the progress chart for the overall project, the Contractor shall submit for approval by the Contracting Officer a bar chart [for each type of [building[[dwelling unit] to be renovated under this contract,] showing the sequence and duration of the various elements of Construction to be performed [on that type of [building] [dwelling unit]]. Any proposed changes to the approved schedule shall be requested by the Contractor in writing a minimum of fourteen (14) calendar days prior to the proposed start of work.

SD-09 Reports

Inspection of Existing Conditions; FIO.

A written report with color photographs noting the condition of the existing facilities at the time of the inspection. One copy of the report including photographs shall be submitted to the [[Barbers Point] [Fort Shafter] [Hickam] [Kaneohe] [Pearl Harbor] [Schofield] Area Family Housing Office] [Contracting Officer], prior to construction.

SD-18 Records

Dust Control; GA.

Method(s) of dust control.

Excavation/Trenching Clearance; FIO.

Prior to start of any excavation or trenching work, the Contractor shall obtain clearance, in writing, from the appropriate communications agency and base or area engineer. Copies of all correspondence shall be provided the Contracting Officer. Normal coordination time for obtaining the necessary permits is approximately fifteen (15) calendar days. The Contractor shall advise the Contracting Officer promptly when it appears that the normal coordination time will be exceeded.

Condition of Contractor's Operation or Storage Area; FIO.

The Contractor shall submit to the Contracting Officer photographs and/or videos depicting the condition of the Contractor's Operation or Storage Area.

1.2 CONTRACTOR QUALITY CONTROL

To assure compliance with contract requirements, the Contractor shall establish and maintain quality control for materials and work covered by all sections of the TECHNICAL REQUIREMENTS in accordance with Section 01451 CONTRACTOR QUALITY CONTROL. Records shall be maintained for all operations including sampling and testing.

1.3 AS-BUILT DRAWINGS

As-built drawings shall be in accordance with SPECIAL CONTRACT REQUIREMENT entitled "AS-BUILT DRAWINGS".

1.4 DUST CONTROL

****

NOTE: If Section 02220 Demolition is made part of these project specifications, retain the first bracketed sentence and delete the second bracketed sentences.

****

[Dust control shall be in accordance with Section 02220 DEMOLITION.] [The amount of dust resulting from the Contractor's work shall be controlled to prevent the spread of dust to occupied portions of the construction site and to avoid creation of a nuisance in the surrounding area. Use of water will not be permitted when it will result in, or create, hazardous or objectionable conditions such as flooding and pollution.] Measures shall also be taken for dust control along haul routes and equipment parking areas.

1.5 PROTECTION

The Contractor shall take all necessary precautions to insure that no damages to private or public property will result from his operations. Any such damages shall be repaired or property replaced by the Contractor in accordance with the CONTRACT CLAUSES entitled "PERMITS AND RESPONSIBILITIES" and "PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS", without delay, and at no cost to the Government.

1.5.1 Warning Signs and Barricades

The Contractor shall be responsible for posting warning signs or erecting temporary barricades to provide for safe conduct of work and protection of property.

1.5.2 Protection of Grassed and Landscaped Areas

The Contractor's vehicles shall be restricted to paved roadways and driveways. Vehicles shall not be driven or parked on grassed and/or landscaped areas except when absolutely necessary for the performance of the work and approved in advance by the Contracting Officer. Grassed or landscaped areas damaged by the Contractor shall be restored to their original condition without delay and at no cost to the Government.

1.5.3 Protection of Trees and Plants

Where necessary, tree branches and plants interfering with the work may be temporarily tied back by the Contractor to permit accomplishment of the work in a convenient manner, so long as they will not be permanently damaged thereby. If this is not feasible, they may be pruned, subject to written approval by the Contracting Officer.

1.5.4 Protection of Building From the Weather

The interior of the building and all materials and equipment shall be protected from the weather at all times.

1.6 RESTORATION WORK

Existing conditions or areas damaged or disturbed by the Contractor's operations shall be restored to their original condition, or near original condition as possible, to the satisfaction of the Contracting Officer.

1.7 REMOVAL AND DISPOSAL

****

NOTE 1: If Section 02220 Demolition is made part of these project specifications, retain the first bracketed sentence and delete subparagraphs 1.7.1 and 1.7.2.

NOTE 2: If there are items to be salvaged, include Section 02050 Demolition in project specifications.

****

[Removal and disposal shall be in accordance with Section 02220 DEMOLITION.] The Contractor shall salvage or recycle waste to the maximum extent practical as it relates to the capabilities of local industries. A record of the quantity of salvaged or recycled materials shall be maintained by the Contractor during the length of the project and submitted to the Contracting Officer at acceptance of the project. Quantities shall be recorded in the unit of measure of the industry. Reuse of materials on the site shall be considered a form of recycling. An example of such reuse would be the use of acceptable excavated materials as fill.

1.7.1 Title to Materials

Title to all materials and equipment to be removed, except as indicated or specified otherwise, is vested in the Contractor upon receipt of notice to proceed. The Government will not be responsible for the condition, loss or damage to such property after the Contractor's receipt of notice to proceed. Items indicated to be removed shall be removed and disposed of by the Contractor [as indicated] [as designated] [outside the limits of Government-controlled property] at the Contractor's responsibility and expense before the completion and final acceptance of the work [for each [building] [dwelling unit]], and such materials shall not be sold on the site.

1.7.2 Rubbish and Debris

Rubbish and debris shall be removed from Government-controlled property daily unless otherwise directed, so as not to allow accumulation [inside or outside the building]. Materials that cannot be removed daily shall be stored in areas designated by the Contracting Officer.

1.8 INTERFERENCE WITH GOVERNMENT OPERATIONS

The Contractor shall establish work procedures and methods to prevent interference with existing operations within or adjacent to the construction area. Free passage into adjoining or adjacent buildings not in the contract will not be permitted except as approved by the Contracting Officer. Procedures and methods shall also provide for safe conduct of work and protection of property which is to remain undisturbed.

1.8.1 Coordination

The Contractor shall coordinate all work with the Contracting Officer to minimize interruption and inconvenience to the occupants or to the Government. Scheduling and programming of work will be established during the pre-construction conference.

1.8.2 Materials and Equipment

****

NOTE: This paragraph was developed for and will be retained for family housing projects. Specifically projects in which interruption to occupants of buildings being repaired and disturbance of the neighborhood must be minimized.

This paragraph may be used on other projects as required, but normally is deleted.

****

All materials and equipment required to complete the project shall be on hand before work is started.]

1.8.3 Utilities and Facilities

All utilities and facilities within the [area] [building] [dwelling units] shall remain operable and shall not be affected by the Contractor's work, unless otherwise approved in writing in advance by the Contracting Officer.

1.8.4 Staking and Flagging Existing Utilities

****

NOTE: Unless utility work is extensive, or if existing utility lines are sensitive, delete

requirements for locating existing utility lines by walking trench alinements with pipe and cable locating equipment.
****

The Contractor, prior to start of any excavation or trenching work, shall verify the location of all utility lines shown on the drawings which are within the areas of work, and shall mark, stake, or flag each utility line along trench alignments and under areas of excavation under this project, as approved. [Existing utility lines shall be located by walking trench alignments with approved equipment for locating underground pipes and cables.] Utility lines so located shall be noted on the drawings.

1.8.5 Smoking

****
NOTE: This paragraph will be retained for all projects at Tripler Army Medical Center.
****

Tripler Army Medical Center has been designated a NO SMOKING area. At no time will smoking be allowed within the hospital, including all construction areas within the hospital. Smoking will be allowed only on the exterior ground level of the hospital 50 feet from the building.

1.9 CONTRACTOR'S OPERATIONS OR STORAGE AREA

****
NOTE: Coordinate the Contractor's Operations or Storage Area with the Technical Manager at POD. The Contractor's Operations or Storage Area should be shown on the drawings, including dimensions, and this paragraph edited accordingly.
****

At the request of the Contractor, an open operations or storage area [of approximately _________ square feet] will be made available within the installation, [as shown on the drawings] [the exact location of which will be determined by the Government]. The Contractor shall be responsible for the security necessary for protection of his equipment and materials, and shall maintain the area free of debris. No rusty or unsightly materials shall be used for providing the secure measure and such measure shall be erected in a workmanlike manner. Before any construction commences on establishing the operation/storage area, Contractor shall take photographs and/or videos of the site in order to establish the original conditions of the site. A duplicate set shall be made and submitted to the Government for its files. Upon completion and prior to the final acceptance of the contract work, the Contractor shall restore the area to its original condition.

1.10 GOVERNMENT PROJECT OFFICE

****
NOTE: Obtain requirements for Government project office from the Technical Manager at POD. If required, retain paragraph and modify as necessary.
****

The Contractor shall provide, for use by Government supervisory and inspection personnel, a job-site office space with a floor area not less than 150 square feet. This office space may be within the Contractor's project office building if adjacent to the job site and if separated by a solid partition; otherwise a separate facility, adjacent to the job site, shall be provided with windows and screens, electricity, including a minimum of four (4) wall outlets and two (2) ceiling lights, a telephone, a desk with drawers, a layout table, two (2) chairs, a legal size five-drawer locking file cabinet, and a fire extinguisher. Potable drinking water and temporary toilet facilities shall be made available to Government personnel, not necessarily within the project office, but in close proximity thereof. The cost of utilities including telephone, and operation and maintenance costs of the Government project office shall be borne by the Contractor. The Government will be responsible for its long-distance calls. Upon completion of the project, the project office and furnishings shall be removed and disposed of by the Contractor.

1.11 INSPECTION

1.11.1 Final Inspection and Acceptance

The Contractor shall give the [Barbers Point] [Fort Shafter] [Hickam] [Kaneohe] [Pearl Harbor] [Schofield] Area Family Housing Office, through the Contracting Officer, a minimum of fourteen (14) calendar days advance notice prior to final inspection [of each [building] [dwelling unit]] for acceptance by the Contracting Officer. All deficiencies found on final inspection [of each [building] [dwelling unit]] shall be promptly and satisfactorily corrected by the Contractor upon notification by the Contracting Officer.

1.12 WORKING DIRECTIVES

****

NOTE: Paragraphs 1.12.1 through 1.12.8 were developed for and will be retained/edited for family housing projects only for the following conditions: a. Interior work in occupied units. b. Interior work in unoccupied units. c. Exterior work on units that may be occupied or unoccupied. d. Exterior site work.

****

1.12.1 Working Hours

All work shall be performed between the hours of 0730 to 1600 HST, Monday through Friday. No work shall be accomplished on Saturdays, Sundays, and all federal holidays without written permission from the Contracting Officer. Such written permission shall be available at the job site at all times during construction.

1.12.2 Occupancy

[Building] [Dwelling units] to be renovated under this contract [will] [may] be [occupied] [unoccupied] during the time of construction. At times, and as directed by the Contracting Officer, the Contractor will be required to deviate from the approved schedule to accomplish work in the [buildings] [dwelling units] that have been recently vacated, and to work out of sequence for the occupants' convenience. If a [building] [set of dwelling units] becomes unavailable on the scheduled availability date due to exigency, the Government reserves the right to cancel the item of work, to substitute another [building] [set of dwelling units], or to reschedule the particular [building] [set of dwelling units] at a later date.

1.12.3 Availability of Work Areas

a. [The Contractor shall limit his work to __ [building(s)] [dwelling unit(s) at any given time.] [After approval of the Contractor's schedule and within [ninety (90)] [___] calendar days after receipt of notice to proceed, the [building(s)] [dwelling unit(s)] will be made available to the Contractor in the following order:

b. Initially a minimum of [______ buildings] [one increment of dwelling units consisting of at least _______________ and not more than _____________ dwelling units] will be made available to the Contractor, but in no case prior to the Contracting Officer's approval of the Contractor's progress chart and such time as the Contracting Officer is assured that no undue work stoppage is likely to be caused by the lack of materials, equipment, or personnel.

c. [___ additional buildings] [An additional increment of dwelling units (consisting of at least ____________ and not more than dwelling units)] will be made available to the Contractor upon satisfactory completion and acceptance of the initial [buildings] [increment of dwelling units] and its acceptance by the Contracting Officer. Thereafter, upon satisfactory completion and acceptance of the [building(s)] [dwelling unit(s)], an equivalent number of [building(s)] [dwelling unit(s)] will be made available to the Contractor.]

d. All required construction at a particular [building] [dwelling unit] shall be completed within [five (5)] [____] consecutive work days after that [building] [dwelling unit] is made available to the Contractor. Once the work has started, the Contractor shall continue performance through each workday until completion, except for lunch periods and other normal breaks. The Contractor shall ensure that all required materials and equipment are on hand, including adequate work force before starting work. Work stoppage will not be permitted without the approval of the Contracting Officer.

1.12.4 Obtaining Keys to Unoccupied Dwelling Units

The Contractor shall be responsible for obtaining keys from the [Barbers Point] [Fort Shafter] [Hickam] [Kaneohe] [Pearl Harbor] [Schofield] Area Family Housing Office to all unoccupied (vacant) dwelling units requiring work and shall return said keys immediately upon completion of work. The Contractor shall be responsible for the cost of replacing any keys that are lost. If the Contracting Officer determines that the locks must be replaced because of this loss, the Contractor shall also pay for this replacement.

1.12.5 Notification of Occupants

a. The initial notification of the occupants, including their responsibilities, will be accomplished by the [Barbers Point] [Fort Shafter] [Hickam] [Kaneohe] [Pearl Harbor] [Schofield] Area Family Housing Office.

b. After the Schedule has been approved, the affected occupants shall be notified by the Contractor of the date and time work will begin in that [building] [dwelling unit] and to remove or safeguard their valuables and personal effects.

c. The Contractor shall by letter notify each dwelling unit a minimum of seven (7) calendar days prior to commencement of work on that [building] [dwelling unit]. This notification shall include the time, the date, and any pertinent changes to the progress chart or any special requirements approved by the Contracting Officer. If the scheduled work is delayed for any cause, the affected occupants shall be notified immediately in writing by the Contractor, and they shall be notified again in writing by the Contractor prior to the commencement of rescheduled work. The Contractor shall include the following information in all delay and rescheduling notices:

(l) Title of Contract
(2) Originally Scheduled Date of Work
(3) Cause of Delay
(4) Rescheduled Date of Work
(5) Family Housing Office Point of Contact
(6) Family Housing Office Telephone
(7) Contractor's Point of Contact
(8) Contractor's Name and Telephone

1.12.6 Non-Availability of Work Areas

If the Contractor cannot gain entry into an occupied [building] [dwelling unit] after notifying the occupants twice; or the occupants refusal to [permit access to their unit] [vacate], the Contractor shall immediately notify the Contracting Officer for substitution and subsequent rescheduling of the [building] [dwelling unit].

1.12.7 Appliances and Major Furnishings

The Contractor shall move all appliances and major furnishings as necessary for accomp1ishing the work, and shall take appropriate measures to insure that existing flooring and items moved will not be damaged by such movement. [In occupied dwelling units, the Contractor shall reinstall or replace appliances and major furnishings in their original locations at the end of each work day, unless otherwise authorized by the Contracting Officer.]

1.12.8 Electricity and Water

In occupied dwelling units, electricity and running water shall be made available to the occupants during non-working hours and on weekends and holidays. [In addition, at least one water closet with running water will be made available for the private use of the occupants at all times including working hours.]

PART 3 EXECUTION (NOT APPLICABLE)